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Bulletin 17

NEW YORK STATE SCIENCE TEACHERS ASSOCIATION

PROCEEDINGS OF THE

SIXTH ANNUAL CONFERENCE

Held at Syracuse University, Syracuse, December 27-28, 1901

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1902

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High School Department

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Bulletin 17

New York State Science Teachers Association

PROCEEDINGS OF THE

SIXTH ANNUAL CONFERENCE

Held at Syracuse University, Syracuse, December 27-28, 1901

SUMMARY OF SESSIONS

Friday, December 27, 9.30 a. m.

Meeting of executive council

Registration

Opening session; called to order by Professor CHARLES W. HARGITT, Syracuse University

Address of welcome

Professor CHARLES W. HARGITT

Response

Professor FRANKLIN W. BARROWS, Buffalo Central High School, president-elect

Value of Research Work in the Training of the Science Teacher

Professor SAMUEL J. SAUNDERS, Hamilton College, Clinton

Discussion

Professor CHARLES W. HARGITT, Syracuse University

Professor A. J. GROUT, Brooklyn Boys High School

Inspector ARTHUR G. CLEMENT, Regents office, Albany

Professor FRANKLIN N. JEWETT, Fredonia Normal School

Professor GEORGE M. TURNER, Masten Park High School, Buffalo

Professor N. A. HARVEY, Chicago (Ill.) Normal School

Professor SAMUEL J. SAUNDERS, Hamilton College

Professor ALBRO D. MORRILL, Hamilton College, Clinton

Friday, 2 p. m.

General session

The Study of Types

Professor N. A. Harvey, Chicago (Ill.) Normal School

Discussion

Professor Grant Karr, Oswego Normal School

Professor Charles W. Hargitt, Syracuse University

Professor N. A. Harvey, Chicago (Ill.) Normal School

Professor Albert P. Brigham, Colgate University, Hamilton

Friday, 4 p. m.

Section meetings

Section A—Physics and chemistry. Professor J. M. Jameson, Pratt Institute, Brooklyn, *chairman*

Preparation and Training of the Teacher of Physics

Professor Charles B. Thwing, Syracuse University

Discussion

Professor George M. Turner, Masten Park High School, Buffalo

Professor W. M. Booth, Cortland Normal School

Professor Charles B. Thwing, Syracuse University

Inspector Charles N. Cobb, Regents office, Albany

Professor Howard Lyon, Oneonta Normal School

Professor Charles F. Binns, N. Y. State School of Clay Working and Ceramics, Alfred

Professor H. J. Schmitz, Geneseo Normal School

Preparation and Training of the Teacher of Chemistry

Professor Lyman C. Newell, Lowell (Mass.) Normal School

Section B—Biology. Professor Henry R. Linville, DeWitt Clinton High School, New York, *chairman*

Preparation of Secondary Teachers in Biology

Professor Francis E. Lloyd, Teachers College, New York

Discussion

Inspector Arthur G. Clement, Regents office, Albany

Professor Francis E. Lloyd, Teachers College, New York

Professor Henry R. Linville, DeWitt Clinton High School, New York

Professor Frank M. McMurry, Teachers College, New York

What the Teacher of Botany in Secondary Schools should be Prepared to Do

Professor A. J. GROUT, Brooklyn Boys High School

Discussion

Professor FRANCIS E. LLOYD, Teachers College, New York

Section C—Earth science. Professor RICHARD E. DODGE, Teachers College, New York, *chairman*

Geography for Training Students in Normal Schools

Professor AMOS W. FARNHAM, Oswego Normal School

Professor C. STUART GAGER, New York State Normal College, Albany

Relations of Life to Environment

Principal C. T. MACFARLANE, Brockport Normal School

Position of Anthropo-geography in Normal School Teaching

Professor W. S. MONROE, Westfield (Mass.) Normal School

Discussion

Professor FRANK CARNEY, Ithaca High School

Professor ALBERT P. BRIGHAM, Colgate University, Hamilton

Professor C. STUART GAGER, New York State Normal College, Albany

Principal C. T. MACFARLANE, Brockport Normal School

Professor W. S. MONROE, Westfield (Mass.) Normal School

Professor RICHARD E. DODGE, Teachers College, New York

Section D—Nature study. Mrs MARY ROGERS MILLER, College of Agriculture, Cornell University, Ithaca, *chairman*

What is the Minimum Nature Study Training for a Teacher in an Elementary School?

Superintendent DARWIN L. BARDWELL, Binghamton High School

Discussion

Mrs MARY ROGERS MILLER, Cornell University, Ithaca

Superintendent DARWIN L. BARDWELL, Binghamton High School

Where and How can Nature Study Training be Obtained?

Miss ELIZABETH CARSS, Teachers College, New York

Miss ALICE CYNTHIA KING, Utica City Training School

Discussion

Mrs Mary Rogers Miller, Cornell University, Ithaca

Professor C. S. Sheldon, Oswego Normal School

Professor Arthur E. Hunt, Manual Training High School, Brooklyn

Professor N. A. Harvey, Chicago (Ill.) Normal School

Professor John W. Spencer, Cornell University, Ithaca

Superintendent I. E. Young, New Rochelle High School

Suggestions for a Teachers Class in Nature Study

Principal Channing E. Beach, Buffalo school 23

Saturday, December 28, 9.30 a. m.

Section A—Physics and chemistry. Professor J. M. Jameson, Pratt Institute, Brooklyn, *chairman*

College Entrance Preparation of Students, as Viewed from the Secondary School Man's Standpoint

Professor R. J. Kittredge, Schenectady Union Classical Institute

Discussion

Professor H. J. Schmitz, Geneseo Normal School

Professor Charles F. Binns, N. Y. State School of Clay-Working and Ceramics, Alfred

Chemical Laboratory Notes

Professor Charles M. Allen, Pratt Institute, Brooklyn

Discussion

Professor Ernest N. Pattee, Syracuse University

Professor Durward E. Burchell, Oswego Normal School

Professor Charles M. Allen, Pratt Institute, Brooklyn

How to Meet the Problem of Teaching Physics by the Laboratory Method in Secondary Schools

Professor Frank M. Gilley, Chelsea (Mass.) High School

Section B—Biology. Professor Henry R. Linville, DeWitt Clinton High School, New York, *chairman*

Ideals in Teaching

Professor Albro D. Morrill, Hamilton College, Clinton

Discussion

Professor Henry R. Linville, DeWitt Clinton High School, New York

Professor A. J. Grout, Brooklyn Boys High School

Professor A. D. Morrill, Hamilton College, Clinton
Professor N. A. Harvey, Chicago (Ill.) Normal School
Professor Charles W. Hargitt, Syracuse University
Professor Francis E. Lloyd, Teachers College, New York
Professor Eugene B. Callahan, Richfield Springs High School

The Training of a Science Teacher for Secondary Schools
Professor N. A. Harvey, Chicago (Ill.) Normal School
Discussion
Professor Francis E. Lloyd, Teachers College, New York
Professor A. J. Grout, Brooklyn Boys High School
Professor Charles W. Hargitt, Syracuse University
Professor Grant Karr, Oswego Normal School

Section C—Earth Science. Professor Richard E. Dodge, Teachers College, New York, *chairman*

Report of the committee of seven
Professor Richard E. Dodge, Teachers College, New York
Discussion
Inspector Charles F. Wheelock, Regents office, Albany
Miss Elizabeth E. Meserve, Utica Free Academy
Professor Albert P. Brigham, Colgate University, Hamilton
Professor W. W. Clendennin, Wadleigh High School, New York
Professor Frank Carney, Ithaca High School
Principal George H. Walden, Rochester school 10

Section D—Nature study. Mrs Mary Rogers Miller, College of Agriculture, Cornell University, *chairman*

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Principal C. R. Drum, Montgomery School, Syracuse
Discussion
John W. Spencer, Syracuse University
Principal C. R. Drum, Montgomery School, Syracuse

Informal talks
Miss Elizabeth Whittaker, Brookton
Miss Mary E. Hill, Goodyear-Burlingame School, Syracuse
Miss Bessie DeWitt Mershon, Utica
Principal R. J. Round, Elmira school 3

Saturday, 11.15 a. m.

General session

Report of committee on a standard college entrance in botany
Professor FRANCIS E. LLOYD, Teachers College, New York

Symposium: What Ought the High School Teacher in each Science to Know? What Ought he to be Able to Do? What are his Opportunities for Self-improvement?
Professor LYMAN C. NEWELL, Lowell (Mass.) State Normal School
Professor HENRY R. LINVILLE, DeWitt Clinton High School, New York

Saturday, 2 p. m.

General session

Report of progress of the committee on stimulants and narcotics presented by
Professor IRVING P. BISHOP, Buffalo Normal School, *chairman*

Alcohol Physiology in the Public Schools
Professor W. O. ATWATER, Wesleyan University, Middletown Ct.

Statement concerning Steele's *Hygienic Physiology*
Mrs MARY H. HUNT, superintendent of scientific department of Woman's Christian Temperance Union

Discussion
Dr HENRY D. DIDAMA, Syracuse University
Mrs MARY H. HUNT, superintendent of scientific department of Woman's Christian Temperance Union
Professor IRVING P. BISHOP, Buffalo Normal School
Professor BURT G. WILDER, Cornell University, Ithaca
Mrs ELLA A. BOOLE, Brooklyn, president of New York State Woman's Christian Temperance Union
Professor ALBERT P. BRIGHAM, Colgate University
Mrs CORA D. GRAHAM, Syracuse, Frances Willard Memorial Union
Professor FRANK CARNEY, Ithaca High School
Professor RICHARD E. DODGE, Teachers College, New York
Mrs MARTHA M. ALLEN, superintendent nonalcoholic medication for national Woman's Christian Temperance Union

Adjourned

SUMMARY OF ACTION

Appointments

Friday afternoon the following committees were appointed to report at the final session.

Nominations. Professor W. H. Lennon, Brockport, chairman; E. R. Whitney, Binghamton; Professor George M. Turner, Buffalo.

Resolutions. Professor Francis E. Lloyd, New York, chairman; Arthur G. Clement, Albany.

Auditing committee. O. C. Kenyon, Syracuse, chairman; John W. Greenwood, Buffalo.

Report of meeting of executive council

Saturday afternoon the secretary made the following oral report:

Recommended, That the association pay to the Regents office for proceedings of the fourth annual meeting, $50.

That the bill for postage for mailing to members the proceedings of the fifth annual meeting be paid, $27.

That the bill for reprints of the papers read at the fifth annual meeting be approved, $62.61.

That the bills for taking and transcribing the notes at the fifth annual meeting be paid, $62.75.

That the expenses of the committee on narcotics be paid by the association, $30.

The secretary stated further that at the meeting of the executive council held at the Hotel Warner the previous evening the place for the next meeting was discussed; that the invitation from Buffalo was presented and discussed, and that it was finally

Voted, That it be recommended to the association that the city of Syracuse be selected for the next annual meeting, and that Prof. Lovell be appointed a committee of one to confer with the Associated Academic Principals and if possible arrange for a session in unison.

Also that, on the recommendation of Prof. Dodge, it was

Voted, That there be appointed a chairman and secretary for each of the four sections, and that the appointment thereof be left in the hands of the president and council.

All the recommendations of the executive council were unanimously approved and adopted.

Treasurer's report

For the year ending Dec. 28, 1901

Receipts

From O. C. Kenyon, treasurer	$226 54	
Annual dues	128 ..	
Interest	1 50	
		$356 04

Payments

Stenographers for the fifth annual meeting	$62 75	
Stationery and blanks	12 75	
1899 reports, paid to the Regents	50 ..	
Postage	10 ..	
Mailing 1900 reports	27 ..	
Reprints, J. B. Lyon	62 61	
Printing programs and letter	22 50	
Mailing programs and letter	13 ..	
Express and cartage	1 45	
Five dinner tickets for guests	3 75	
C. W. Hargitt, expense	65	
F. W. Barrows, expense	4 15	
H. R. Linville, expense	50	
Trunk Line Association	4 ..	
Labor and clerk hire	27 ..	
		302 11
Balance on hand Dec. 27, 1901		$53 93

Committee reports

Nominations. The committee recommended the following as officers of the association for the ensuing year, and they were unanimously elected.

President, William Hallock, Columbia University

Vice-president, Howard Lyon, Oneonta Normal School

Secretary and treasurer, A. R. Warner, Auburn High School

Executive council, E. S. Babcock, Alfred University; H. J. Schmitz, Geneseo Normal School; W. M. Bennett, Rochester High School

Resolutions. The following resolutions were reported and adopted.

We, the members of the New York State Science Teachers Association, assembled in conference at Syracuse N. Y. Dec. 27 and 28, 1901, do hereby extend our most hearty thanks to those who have so liberally contributed to our comfort and convenience,

To the city of Syracuse for the use of the city hall where we are at present,

To the university authorities, and more specially to the dean and faculty of the medical college, for their courtesy in extending to the association the use of their building,

And to Prof. C. W. Hargitt, Mr O. C. Kenyon and Mr J. D. Wilson, the local committee, for the efficient way in which they have arranged for the details of the meeting.

We hereby resolve that a copy of this minute be copied on the records of the association, and that the secretary be instructed to convey in writing the sense of the resolution to those mentioned.

The following resolution from the earth science section was presented and adopted.

Resolved, That the committee of seven be continued for one year, that they may outline a series of laboratory exercises in physical geography, and suggest a course of study in geography for elementary schools.

Auditing committee. The auditing committee has examined the accounts and report of the treasurer, A. R. Warner, and finds them to be correct.

JOHN W. GREENWOOD
O. C. KENYON

Miscellaneous

Friday afternoon Inspector Charles N. Cobb called attention to the fact that in connection with the Associated Academic Principals meeting there had been arranged an exhibit of science apparatus for physics and chemistry particularly, on the second floor of the Yates hotel at the end of the corridor at the left after leaving the elevator.

ADDRESSES, PAPERS AND DISCUSSIONS

Friday morning, December 27

GENERAL SESSION

Prof. C. W. Hargitt—In the absence of the retiring president, I have been asked as chairman of the local committee to call the meeting to order and to introduce the president-elect. It is not necessary to spend time in words of formal welcome. The sixth annual session makes the third out of a series held in Syracuse, and the second of a series held in this building. I am very sure that those of you who have been at previous meetings are quite aware of the fact that as teachers and as science teachers, you are welcome in Syracuse and here in this building. I think moreover that no words of mine are necessary in the way of congratulation to the science teachers of the state on the work of this association in the past years of its history. A glimpse at the program in the standard of work proposed for this meeting and in the quality of material in the way of speakers provided to participate in the work of the session is sufficiently assuring on this point. We have been strikingly favored in the brief years of our history in being able to command the services not only of the science teachers of the state, but of many of the foremost science teachers and investigators of the country. Our scientific friends have been more than generous in this respect. They have come to us from the older East and from the younger, if not more active and enterprising West, and have contributed each in his way to the promotion and success of the work of the Science Teachers Association.

Without further multiplying words, I may simply say that you are welcome to Syracuse University and to the medical department, under whose roof we are housed today. It is now my pleasant privilege and honor to introduce to you the president-elect, Dr Franklin W. Barrows of the Buffalo High School.

Dr Franklin W. Barrows—*Mr Chairman, Ladies and Gentlemen:* I am sure that the small attendance at this opening meeting need not discourage us in any way, for the fact that we have

accepted the hospitality of Syracuse University is a good omen. Our meetings in Syracuse have always been satisfactory and enthusiastic. You, Dr Hargitt, and the university are assured that we feel at home with you and in your city. It is both fortunate and unfortunate that there are two associations meeting here at the same time which demand the attention and interest of our members. The reason that we have not more at this opening session is because a number of our members are in the meeting of the associated principals and some of them are taking part in the program.

We are fortunate this year in that we have been able to make some progress in the work for which the association was organized. Two committees are working on important topics. A committee of seven are at work on the subject of earth science and the suggestion of courses of study. The committee on stimulants and narcotics, five members under Prof. Bishop, reports its progress tomorrow afternoon.

It is not necessary to inform those who have looked over our program that for this session the papers have been selected with the central idea of suggesting the proper preparation and training of science teachers. The program has somewhat the appearance of sameness, in that the phrase "the training of teachers" appears in so many places in the announcements of the section meetings and of the general convention. This is no mistake nor oversight. The committee, the members of the council and the chairmen of the sections have striven to emphasize this matter more than ever before, and perhaps with the special view of being helpful to teachers in the secondary schools.

Without further remarks on the program or on the other features of the meeting, it gives me great pleasure to introduce to you a gentleman who, as a professor in the colleges of the state, has had as much to do as anyone with the equipment and training of science teachers. I have the pleasure of introducing Prof. Samuel J. Saunders of Hamilton college, who will address you on the "Value of research Work in the Training of the Science Teacher".

VALUE OF RESEARCH WORK IN THE TRAINING OF THE SCIENCE TEACHER

BY PROF. SAMUEL J. SAUNDERS, HAMILTON COLLEGE

We often hear the opinion expressed that the modern methods of education do not produce as good results as the old-fashioned ones. Is this true, or is it but the croak of the pessimist? Be that as it may, the questions and discussions at such gatherings as this make it evident that our modern methods are not yet entirely satisfactory. Is the fault in the choice of subjects, or in the teachers and their training? What do we mean by "good results"? What do we ask our teachers to do for us, and for our rising generation? These questions seem to bring us to a consideration of the best methods of education.

The test of every educational system is the product which it forms. It should produce men who think and decide for themselves, men of action, who make their mark in the world, who succeed in whatever they undertake, whether the problem be scientific or social. It should make of the average man an intelligent, clear-thinking, truth-loving and cultured citizen. The object of education is to expand and train the mental faculties, to teach people how to think for themselves; and *that* discipline is the most valuable which makes us the most self-reliant, and enables us to make the best use of our reason and judgment with respect to all matters pertaining to our own welfare and that of the community.

In that delightful book, *Helen's Babies*, the author strikes a chord which finds a response in every human breast, when he represents the three year old hero insisting that his uncle open his watch and let him "shee wheels go wound". For centuries that cry has gone up from the children of men. All are curious to peer into the machinery of the universe and learn if possible how and why the "wheels go round". There is a deep seated desire in every child to find out the reason of things, and this spirit of inquiry should be fostered and developed; it is one of the first essentials in research.

The work of the school should connect with the child's previous interests, and continue the educative process of the earliest years, which is always of the nature of original research. The excellence of science, as a means of teaching people how to think, is no longer questioned. Even with a view to culture, science, when properly taught, is one of the best means of educating the highest faculties of the human mind. By proper teaching we do not mean the mere learning of a lot of scientific facts, but discipline in the methods of science. Mere head knowledge may do a man very little good; it is the habit of mind and the training in method that determines the character of the man. As an instrument of human progress the greatest value of science is manifested in scientific inquiry, or research, and no amount of mere learning, or mechanical skill, can take its place. The progress in science and industry is due to the spirit of inquiry and inventiveness developed by research methods of training, and these methods should be applied throughout the whole educational course of every individual.

What do we mean by the research method? We may define it briefly as being, "The putting of related experiences together and finding things out for ourselves".

All education, which attains its highest ends, is of the nature of original research. In this sense, that is to say, of adding to our knowledge by our own efforts, we have all been, to a greater or less extent, engaged in research work since the moment of our birth, and there is no period in life when the research method is more accurately and successfully applied than during our early years. The young child learns the meaning of a word, tone, look, or action, by putting together various instances of its occurrence, forming a conception of its significance, testing the correctness of this conception by repeated observations and modifying it as experience widens.

As we grow older, and are able to understand the answers and explanations of others, our power of applying the research method seems to fall off rapidly. The ease with which we can then obtain information by asking questions does away with

the necessity for much mental effort on our part, and we gradually cease to investigate for ourselves, this power dying away with disuse like any other power. Moreover, we fall into the habit of appealing to, and relying on, authority. The child should be placed under such conditions that his desire for the acquisition of knowledge can be kept alive and fostered, and so that he does not lose the habit of systematically searching for truth by the aid of known truths, and testing the validity of each step by constant reference to experience and experiment.

It is important that this power of applying the research method, this acquiring of science-forming ideas, should be raised to as high a pitch of efficiency as possible before we stand face to face with the problems of life. It becomes more and more difficult to begin to apply this method as we advance in years. It is unwise then to postpone its cultivation till we have entered on the special duties of our life work. It should be cultivated, as we have said, during the whole school career from the kindergarten up.

Much of our modern education fails because many subjects, even the sciences, are learned as the dates of important events in history are learned; the memory alone is exercised, reason and judgment do not come into operation, unless it be merely to refer matters to some authority which is considered final. It fails too because the pupil is not trained to apply his knowledge. It is by constantly making practical use of the knowledge we possess that the power of making original application of knowledge is best brought out. The pupil should test his knowledge continuously, and learn "to do by doing". In language study he should translate from one language to the other till he has acquired readiness and facility in the process; in mathematics he must work problems, and in the sciences he must prove his theories by experiment. He should use his knowledge and reasoning with respect to some phenomenon, and then test his ideas by experiment. The result usually shows him that his preconceived opinions must be modified, or perhaps wholly abandoned; that there are laws which must be discovered by patient

labor and investigation. He realizes also, that he must be constantly on his guard against errors, that he must become acquainted with the sources of these errors and learn to fulfil the conditions necessary to avoid them. He may be able to learn a great deal about the truths and principles of science, and their experimental illustrations, by reading about them in a good textbook; he learns more, if in addition to the reading he can see the experimental illustrations and demonstrations performed by another; but he learns most and best by doing them himself. There is nothing that brings the truth home to the mind so well as experimental proofs carefully carried out for one's self. The possession of knowledge does not confer on a man the ability to use it, and the possession is of no value if it can not be used and applied. If our one talent is to gain other 10 talents, it must not be buried in the earth. The research method means simply the using of the knowledge we have, to gain more. For the student, for every one, whatever his profession or calling, there is but one thing essential to success—he must acquire knowledge, and the power to search out knowledge for himself through his own experiences. The man of business must have not only a knowledge of things, but also of principles and methods, and his success is proportional to the skill with which he applies such knowledge. He must note carefully the satisfaction or discontent of his customers, put his experiences together and learn from them general rules, which he makes more and more accurate as time goes on.

That knowledge which we have acquired by serious thinking and hard work we are apt to value and remember; it becomes, at least, a more secure possession than that which has been easily and lazily gathered while enjoying a cigar and fan. The difficulty of a book, or subject, is not in itself an objection to its use in education, for to learn how to overcome difficulties is a very valuable part of the training. Mathematics are hard, and Greek is hard, and that is one of the reasons why they are such excellent educational subjects. In the present day, however, when there is so much to learn, we are always on the lookout

for the royal road, and even when we have done our best to smooth the way, there is considerable difficulty left.

Language study furnishes abundant opportunity for the application of the research method; it involves the continual putting together of the known to arrive at a knowledge of the unknown; a constant modification of, and addition to, our ideas of the meanings and usages of words and phrases, as experience widens. In these studies too much help is often furnished the student. There are grammars and dictionaries giving all the shades of meaning, and minute details regarding the make-up and use of the different words and phrases; there are also the annotated texts furnishing additional notes, and helps over the hard places, to say nothing of the interlinear and literal translations better known as "cribs", "ponies" or "horses".

The sciences are often taught as if the object of the study was simply the acquirement of a store of useful information, and there are epitomes of the latest results in each branch of science which the student can read and memorize. There is nothing of the research method in this, it calls for no original application of knowledge already possessed, no drawing on experience, none of the mental faculties except the memory is exercised to any extent.

Even for the experimental work, there are elaborate manuals in which nearly everything is worked out for the student, and he is told just what to do and how to do it, and what he should expect to see. The work is merely a training in mechanical operations, not intellectual discipline. If he does not obtain the results indicated, he goes over the work again, he relies on authority and not on himself. It is a good thing for the beginner to verify for himself well established laws, and to cultivate manipulative skill and dexterity, but experimental work should also cause the student to observe and think for himself. The misuse of such helps may defeat the highest aims of the studies in which they are used.

Our modern system of education should stand out against the abuse of authority and memory. The lack of time, and the

necessity of mastering a certain amount of information in which examinations have to be passed, are perhaps the main causes of these abuses. Examinations, as they are usually given, test only the memory, not the powers of reasoning and judgment.

Culture does not depend so much on the subjects, as on the method and persistence with which they are pursued. It is no argument against the study of the classics, that the proper study of science makes keen thinkers and able men, for the classics properly pursued will do the same; nor, on the other hand, is it any argument against the sciences that the classics have produced the profound thinkers and eminent scholars of the past. Who will ever know how many thousands there were, during the past centuries, who had no love for the study of classics or mathematics, and who had no opportunity to test the educative power of other studies?

The boys in schools used to be divided, I believe, into classical boys, mathematical boys, and good for nothing boys, this last division existing chiefly because their intellectual blades required a different process of sharpening from the others.

It is estimated that about 2% of all boys are clever, and for a clever boy any subject of study is good enough, one perhaps as good as another, if it enables him to come into close mental contact with great thinkers. But what about work for the other 98%, the average boys and the dull boys? The study of the sciences proves to be the intellectual salvation of many of these. It arouses some minds which nothing else seems to reach, and it develops and trains in all cases faculties which otherwise would have remained dormant.

Progress is always greater when the work is pleasant, and there are so many ways of study offered by the sciences that one has a chance to select that which is most attractive for him, and instruction from the teacher need not change or hinder his own natural method of study. Some branches are almost purely observational; but if he prefers abstract reasoning he takes up the mathematical side; or if he loves to make apparatus and use it he approaches the subject on the experimental side.

A twofold advantage is claimed by the advocates of science studies; first, that they are a means of the best mental training, and second, that they communicate a kind of knowledge which is of practical use in everyday life. It has been said that the teaching which limits the range of a man's vision to the subjects and facts of which he can see the use does not deserve the name of education, the very essence of which is the strengthening of the intellect by mental exercise. But in these days of fierce competition in the industrial world, we must study more and more those truths and principles of abstract science which lie nearest the useful. There are many problems in nature the solution of which would confer great material benefits on mankind in general, and in which the processes and methods involved in carrying them to a successful conclusion, are identical with those which the problems of pure science require, while the discipline and training imparted are equally good. I am not encouraging the idea that utilitarianism should be made the end and aim of education, but what is the advantage of making a close study of the planet Mars, for instance, its markings, its climate and its physical conditions when we know little or nothing of the composition of the earth's crust, or of water, or air or the glass in our windows, or what the nature of the light is that shines through them? The widest culture is the noblest culture. Universality and thoroughness may go together, but why do we so often go far afield for subjects for investigation and study, when there is much that is just as good near at hand, and perhaps more likely to prove useful in everyday life?

There is a kind of knowledge that is actually becoming a necessity. It is that knowledge which best unlocks nature's storehouse, and enables us to wrest from her more than has ever been obtained before, that knowledge which will enable us to find out and use powers of nature which have never been used before. The great success of Germany in commerce and manufactures is due to the particular attention paid to the physical sciences. Sooner or later knowledge and method and industry must tell. Dr Lockyer, the English astronomer, said recently in

an address, "I look upon scientific education as a great and necessary line of defense for our country, perhaps scarcely secondary to our naval and military forces."

The connection between scientific and technical education is a close one. In the laboratories new discoveries are constantly being made, science makes known to us new properties and qualities of matter and mechanical invention applies these discoveries to industrial processes. A thorough training in abstract science is a necessary groundwork for a technical education, for how can one understand the practical applications of a science unless he is familiar with the underlying principles of that science? To specialize without the proper preparation is like building the top story of the house first; when it is completed you have but a one story house, and it sits on the ground.

The applied science of the future is now in the process of formation in the operations of those who are working in pure chemistry and physics. Thousands of investigators are patiently working in the laboratories in all parts of the world to bring out new knowledge, and each year now witnesses more discoveries than a century used to. A renowned painter was once asked which he regarded as his greatest painting; he answered "The one I am about to paint". The greatest discovery in science is "The one that is about to be made". The best teaching inspires the student with the conviction that he also can work out new truths, and make some permanent additions to human knowledge.

A scientific man, as such, is valuable according to the amount of new knowledge he is able to bring out, or if he is not engaged directly in research, according to the number and ability of the workers which he prepares and equips for the bringing out of new knowledge. We lead in the struggle for commercial supremacy among the nations of the world, partly because of our great natural resources, but largely because we have such a good supply of investigators and well trained managers, and workmen competent to take instant advantage of every discovery in science. We must maintain, or even increase, the

number and efficiency of such men, and must afford them the facilities for acquiring the necessary scientific knowledge and training. The investigators and managers perhaps receive their training in the universities or technical schools, but the workmen, who should be sufficiently well trained to take the initiative whenever necessary, must depend entirely on what they receive in the public and high schools. If in these schools they are taught to understand and apply the best known general principles they will be able, later, to master a given set of practical details with readiness and facility. To the science teachers then belongs in a large measure, the task of preparing all these, so far as education is concerned, for their work in life.

Every teacher who teaches science thoroughly is training skilled teachers for the rising generation. He should have not only a thorough knowledge of his subject, but the ability to impart that knowledge to others, and the willingness to do his utmost.

It is, of course, indispensably necessary that he should be well grounded in his work, and should have a thorough comprehension of the methods and principles of his branch of science, but there is for the teacher even though a specialist a great value in general culture. The man of broad culture and refinement seems to impress his ideas on the pupil's mind in a way that makes them stick. The teacher who knows his special subject well, but not much in other lines has difficulty in doing this. The twofold caution so often given by Bacon against overgeneralization on the one hand, and against overspecialization on the other is still as deserving as ever of the attention of mankind.

A man, in climbing to the peak of a mountain, meets with many difficulties, but experiences pleasure in overcoming them and in enjoying as he rises a wider and more commanding view of things beneath him. If now he wishes to guide others to the top, he must come down again to the valley, put himself in close touch with those to be guided, perhaps even roping himself fast to them, and lead them by the way which he took, cut-

ting steps and footholds in the difficult places, and being always ready to cheer and support the drooping and exhausted. He would accomplish nothing by declaiming from the top, however eloquently he might describe the beautiful scene spread out around him, or however vigorously he might shout his directions as to the proper path to take.

Happiness has been defined as "The state of satisfaction engendered by success in surmounting the material difficulties of life". For a clear and vigorous mind it is a source of intense pleasure to master new ideas. The best progress in study is made for the sake of that reward alone. It must have been this pleasure of overcoming the difficult, the love of truth for truth's sake, that led to the researches of the old Greek geometers, for it was not till the time of Galileo and Kepler that the knowledge of conic sections was of the slightest practical use to science; but they built better than they knew, for it is safe to say, that without their contributions there would have been no Kepler, without Kepler no Newton, and without Newton no such conception of nature as we now have, of nature which is subject in its every phenomenon to exact and definite laws.

A recent writer says that science is ever seeking to write in pure symbols, hence it is not comparable with what we understand by literary work. Some of the grandest truths may be presented to the mind by means of pure symbols.

There are truths which can not well be expressed in any other way. It is said that Newton after waiting for years to secure accurate data was so overpowered by emotion, as he neared the end of his calculations, that he was unable to finish them, but called another to do so for him. Yet what Newton saw was a few pure symbols, a simple arithmetical expression. But that simple expression revealed to him the fact that every particle of matter attracts and is attracted by every other in the universe. He was thrilled by emotions which language is powerless to express or describe. Have you ever gazed on a scene of such grandeur and magnificence that you realized that language was perfectly inadequate, that you could not even attempt a

description of your feelings? Then you may understand what he felt.

Speaking now more specially concerning the value of research work proper, we might consider first, the perceptive faculties. One of the first things the student in scientific research must do, is to learn to use his eyes. He must be an accurate observer of the various objects and phenomena with which he is concerned. A great deal of our knowledge, if we are to profit by the labors of others in the same field, must come from books, but we should insist that the learner be taught to observe for himself before he appeals to the experience of others. The ancients seem to have been particularly deficient in the power of observing. They gave much attention to astronomy but they record the number of fixed stars visible to the naked eye as 1600, while we now give the number as nearly 4000. We also give about 20 as the number of nebulae and star clusters visible in our latitudes, while Hipparchus gives two and Ptolemy but five, both of them omitting such remarkable objects as the nebulae in Orion and Andromeda. The constellation of the Pleiads was considered of great importance for navigation and was constantly observed and yet only seven of its stars were discovered. In fact the seventh one was lost sight of for centuries, and ultimately when the middle star in the tail of the Great Bear first attracted attention, the conclusion arrived at was that it was the missing seventh star of the Pleiads. Nowadays cases are known of people who are not astronomers seeing from 14 to 16 stars in the Pleiads, and it is by no means uncommon for people of good sight to see 11. The star Alpha Capricornus has been seen by man for thousands of years without its being noted that it is a double, a fact that any child would discover now, if its attention were directed to the star. It would be interesting to know in how far we inherit a trained eye from generations of ancestors who gradually accustomed themselves to the accurate observation of objects.

In addition to training his perceptive faculties, the student in research must exercise his reasoning powers to work out and understand his observations, systemize them, and compare

them with others. In science we are much more concerned with the quantitative relations than with the qualitative, and as our knowledge increases that part of it which is mathematical also increases and becomes in many cases quite difficult. In planning and conducting operations in research work there is abundant opportunity for the development of the constructive imagination, originality of mind, and inventiveness. He must change his apparatus and appliances to meet the requirements of the problem in hand, or perhaps devise and construct new pieces as he amends his processes. Patient industry and self-denial, which are the first conditions of scientific investigations, develop self-reliance, and impart strength and solidity to character. With what wonderful patience and perseverance did Kepler work! For 22 years he read the face of the starlit heavens, tracing and measuring with patient exactness the positions and paths of his celestial wanderers, before he was able to deduce from his results the laws of their motion. Every notable scientific achievement rests on a long continued series of patient observations.

Research work calls into active play the powers of the imagination. A noted critic has said that the two men whose imaginations were the most brilliant of any of their day were Michael Faraday and Charles Darwin. All the phenomena with which the scientific investigator deals are concerned with the actions of the invisible and unseen on the visible. There are force, energy, electricity, the universal ether, and many other such subjects or conceptions to consider and explain or describe, and the imagination is often unequal to the tasks imposed on it.

A French bishop, who had become greatly troubled over the nebular hypothesis, or the six literal days of *Genesis*, or something of that sort, preached a sermon in which he inveighed fiercely against science and scientific men, with a repetition of that condemnatory vigor which landed Galileo in prison. At the close of the service a noted astronomer went up to him and said "Monseigneur have you never seen God?" "No," said the surprised bishop "I never have." "Then, your grace, I have"

was the reply. "I have seen him in the great cathedral of the universe, I have felt him in the movements of creation, I have witnessed his workings from nebula to star and from star to planet, I have read those scriptures of the sky which you have not, I have touched his robe and know him as a visible being."

In research work our ideas are of value only so far as they are true. Perfect frankness and truthfulness of mind are indispensable to success. Each new problem must be approached with the mind open for the reception of new truth, and all preconceived opinions must be laid aside or held subject to revision. It often requires the utmost skill and attention to sift the truth from the error. One must be careful and accurate both in measurements and statements. Extreme accuracy often leads to valuable discoveries. The discovery of the aberration of light would not have been made if Bradley had not been able to measure accurately to one one hundredth of 1%. To the fact that Rayleigh was not content to allow the small discrepancy of one part in 10,000 to pass unnoticed, the discovery of argon is due.

Scientific investigation trains in mechanical operations, in manual dexterity and manipulative skill. There is constant adjusting and handling of apparatus, and many operations which are apparently easy, require a deftness and accuracy of touch which comes only from practice. Research work strengthens the memory, for the investigator must remember a large number of facts, and their mutual relations. It brings home to the mind of the investigator the fact that he must stand entirely on his own merits. Credentials, certificates and diplomas avail him nothing. He realizes that they are no more than the stamp on a coin, which makes it a counterfeit unless the metal itself be genuine. Last, research is one of the most vital factors in the promotion of civilization, one of the most powerful levers of national prosperity and influence. Time will not allow, if indeed it were necessary, to call attention to the wonderful discoveries of even the past decade. And yet how many of us think of the latest discovery as if it were really the very last

that can be made. Research will never proclaim any proud period and her work accomplished, it grows from more to more. The good ship Discovery is well under way, and the ocean of triumphant progress in unbounded.

Prof. C. W. Hargitt—I hope everybody will not wait for everybody else to-say a word on this very fruitful topic and on the very admirable presentation to which we have listened. Every proposition made, it seems to me, must appeal to all and to some measure become inspirational. Some of us who listened to the address last evening by Pres. Draper concerning the primary duty of the teacher to impart some measure of inspiration, have had brought anew to us this morning the same idea, and I think the reader of this paper has made clear to us that it is not primarily the work of science to afford information alone, but it seems to me that he has made it clear that inspiration is one of its primary ends, and I feel that in so far as the science teacher may fail in that primary end of his work, he fails in his work. What we need is not simply the acquisition of knowledge, of mechanical skill or of technical ability so much as the capacity to inspire the boys and the girls, and whether teachers in the schools or in the higher departments of university or college work, it seems to me that one of the primary aims in science work is to inspire.

Such papers and ideals as these which this association has taken pains to emphasize are among the most hopeful signs of the times. Let us have done with the idea that the aim and end of science is knowledge or skill or even the ability to earn a livelihood, but that it is to open the mind, to remove the scales from blind eyes, to compel deaf ears to hear, to open anew to the rising generation the avenues through which the world of nature around us appeals to us.

Prof. A. J. Grout—At the risk perhaps of anticipating some things I planned to say this afternoon, I want at this time to propose a question which seems to be of vital importance, because there are a number of people here I will not be able to reach this afternoon.

To my mind the greatest obstacle to science teachers doing just the kind of work suggested is the tryanny of examinations, college, Regents, or whatever you call them. Suppose you teach by research methods in the secondary schools, what will it profit you on examination day? And our students must pass the examinations or the work is discredited. The examination of today, as I see it, is a test of cyclopedic knowledge, and I want to suggest one thing now, can not the Science Teachers Association do something to make our examinations not a hindrance but a help along these lines of work?

Inspector Arthur G. Clement—I wish to express my appreciation of the valuable paper presented. It seems to have touched on the fundamental principle which ought to inspire all science teachers, to get the students to discover facts for themselves and not take everything for granted and learn merely from textbooks. We are apt to think that research work is only for people who have studied a long time and who have made some great discoveries and are still endeavoring to make further research.

I think the speaker brought out the point well that even young students are doing research work, provided they take things at firsthand and work out their ideas before looking into the textbooks. I have read somewhere that very many great discoveries have been the result of accident, but it is to be noted that these supposed accidents never occur to people not attempting to do research work. Those doing research work frequently make a discovery other than what they are looking for. Therefore we ought always to encourage students, as they may discover something of great value in the scientific world, though not the truth for which they were seeking.

The last speaker spoke of the tyranny of Regents examinations. As I happen to be in the employ of the Regents, I wish to say just a word and to insist that there is no such tyranny when the examinations are properly used. For instance the examinations given in physics or botany. It can hardly be called tyrannic to ask a student 15 questions, of which only

eight are required to be answered, specially when 15 questions cover quite a range of matter. If the student has done the work it is a very easy matter to sit down and write out answers to eight of them.

Dr Grout—I want to say for myself that I never personally suffered from that tyranny—that those questions in that science are not tyrannic, but can not questions be devised to test the students' power to do the work? Of course most of the questions have to be, under the present system, a test knowledge of the facts. I want to see questions which test the students' ability to do the work, and where a school is equipped with a laboratory, it is practicable.

Inspector Clement—I must insist that the questions are all right. When we ask the student to write out an account of an excursion he has made with the class, dwelling on the observations he has made pertaining to geology or physical geography it is certainly a fair question and gives a chance for a person to tell what he knows. This is simply an illustration.

Prof. Franklin N. Jewett—I am in sympathy with the writer of the paper. I have asked pupils, which they preferred in doing experimental work, to know the result in advance or to discover it, and I have been surprised, not quite dismayed, but surprised and interested at finding that a great majority preferred to know the result in advance. They said that then they liked to work better. I simply know that students are capable of doing fine work under that plan. They are greatly interested and do extra work in the laboratory, and come in after school and work till dark on a process which usually tells what to expect, striving to find the answer as we did in arithmetic when the answer was under the problem and not in the back of the book.

This has not convinced me, however, that the report is to be taken at par. I am not convinced that the sense or experience on which these pupils based their reply was entirely normal or best, but I present the matter and want to know if anyone can tell me how general this impression may be among the pupils; how it takes and how it works. I can not get the con-

viction out of my mind that the proper way is the way of discovery, and I have always wished in later years that I might have had more opportunities for such discovery when younger.

I have also thought—I presume there is no question about it as everybody knows it—that the scientific world is getting its information by reading more than by the laboratory. If I am wrong I would like to be corrected. No people more than scientific people get together and hear each others papers read. That is literary work, textbook work. A man goes through a process, a series of experiments, and his reports are printed and become common property of the scientific world. This feature has its place, as marking humanity and distinguishing it from the lower animals. Where has it a place, in the beginning of school life? When should it come in in large measure? These, to me, practical questions, I do not mention with the expectation of having them entirely settled. There are two sides to the matter and I do not wish to limit either side unduly. I hope to make more observations on this subject.

The question arises how far shall we push conclusions beyond experiments. I must confess I would like to see the experiment tried of teaching some of the sciences to persons who should have no textbooks and no access to textbooks. If any have had such experience, I would be glad to hear from them.

Prof. George M. Turner—I like Prof. Saunders's use of the term "research work". I confess that it has never appealed to me quite as it has this morning. I have always felt that a teacher in a high school was not quite in the position where he could do original work, as a professor in college could. I am willing to grant that I have experienced, and no doubt many others in this room have experienced, such feelings as described, that one might have on finding something new to themselves, not to the world, but to themselves.

The use of the term is a good one. From this standpoint, why do not the boys and the girls do research work every time they go into the laboratory? The work and results are in most cases discoveries from their standpoint. The previous gentle-

man remarks that he thinks his pupils are more inclined to have the answer given before the work than afterward. In many cases I think that is all right. Why not? The pupil does not go into the laboratory, as I understand it, for the purpose of discovering the laws. He is not there for that purpose. He goes there to win the power to use his hands, to train his mind and to draw proper conclusions from what he has done. Why should not the pupil, knowing beforehand what to look for, use his hands just as well? Knowing where and how to look, why should he not have this same satisfaction when he has gotten something new to himself, that the research man has when he finds something new to the world as a whole?

From a personal standpoint, I never shall forget the first time I went into a dark room to develop a plate and brought out an image produced by an x-ray. I had read about the thing. It was not new to the world, but it was decidedly new to me. It was some three or four months after the discovery was announced that I had an opportunity of trying the experiment. A boy had a bullet in his hand which the doctor asked me to locate. I had no faith that I could help the man, but I exposed for that bullet something like one and one half hours. When I took the plate into the dark room it was with a strange kind of a feeling, and when I saw the outline of the hand, and afterward that of the bullet, I can not put it into words how I felt. I just felt a certain degree of enthusiasm, gladness and joy beyond expression. Why should not our boys and girls, even if they have an idea what to expect, enjoy the work and get out of it the same degree of satisfaction that I had, or those have who do entirely original work?

Prof. N. A. Harvey—I have been very much interested in the discussion and very much pleased with the paper itself. There is one idea in the paper that leads me in a direction that I am very glad to go—the use of the term research to mean not the extension of knowledge that the world already possesses, but the extension of the pupil's own knowledge after the manner that research workers employ. Generally we think

of research as being that kind of work which extends the limits of knowledge possessed by the world. I do not know that this use of the term research is above criticism. After all, it carries with it an implication that is very good. It seems to me the only true method. Perhaps it has to come to high school work through that word so common and familiar to us, as applied to workers in universities and great original investigators.

It seems to me it is the only way in which we can do the best work for our pupils in the teaching of science. It is not sufficient for a pupil to work for a known result, as that will not afford the greatest advantage to the pupil.

You know how great the influence of expectation is on an anticipated result. When a person is working with a chemical balance, and the operations are not very delicate and he knows he ought to get a certain number of grams and milligrams for a particular amount of substance he has been working with, it is almost impossible to keep that balance from working out the known amount. It shows that result every time. So in operations for measuring falling bodies, if a person knows he ought to get about a specified amount, he can not prevent it coming right to that point. It will come in spite of himself, and he may be as honest as he pleases. It is that influence which is so disastrous to good work. I have no doubt that a great majority of pupils would prefer to know what they would get. I think if the teacher should put it to a vote, "Now, shall we read this Latin lesson with a pony, or read it without?" I think I know how that class would decide. It would be a very remarkable pupil who would take the other stand conscientiously. There are pupils who, in geometry, will work out demonstrations in an original way and not get help, but most will not do so. They are not remarkable. They are common, everyday people like the rest of us. Not many of us will work out a problem at firsthand. We wish to economize time and effort.

I will say this in answer to a gentleman over there. I have had some experience in doing this in work with classes in *physics* and in chemistry and in zoology particularly, and I

might say in botany, where my effort was to an extent that I thought necessary, directed to keeping reference books, textbooks and answers out of the hands of the pupils. The results were eminently satisfactory to me, and I think, to the pupils. I do not know that they enjoyed it more than they would the other way, but they just took it as a matter of course because it had to be that way. There was a very great difference in the kind of work done from that done where a textbook was put into the hands of the pupils. I have in another place presented this instance as an example of a general principle. It is the clearest evidence I know of. For three successive years I taught two classes a day in physics in a normal school, in which the students had had different experiences before entering the school. One was a class of high school graduates, all the members of which had studied Avery's *Physics* and had various experience in laboratories. Laboratories had not been of the same kind. Some were good and some bad, and perhaps some had not done laboratory work. The other class had never studied physics. The two classes were taught in the same studies, with the same experiments in laboratory, and the same teacher. There was the best possible opportunity for comparison, where every other variation was eliminated, it seemed to me, except the one of previous different experience. In a part of the work the experiments and exercises were just as new to those who had studied physics as to those who had never studied it, but this seemed to make no difference whatever. I very soon found that those who had not studied physics before had a better result than those who had studied, and in seven cases out of 10, the class who had never studied physics obtained more nearly accurate results on the average, than those who had studied it. The textbooks were kept away from the students who had studied physics before, yet they certainly had a knowledge of what some of the answers should be. The only interpretation I could make was that the teaching of physics to those pupils with a textbook in hand had detracted from their ability to obtain correct results by their

own original observation at firsthand. Proof of the same fact would be more difficult to obtain in botany and zoology.

It seems to me the paper has stated the profoundest principle of pedagogy in teaching physics. I don't know very much what good we are going to get out of it, if not that.

I would like to ask the gentleman who spoke about examinations, what kind of examinations to give. I am very much interested on both sides. I happen to be teaching classes that undergo examinations. I happen also to be on the examining committee for Chicago which examines applicants for entrance to the normal school, for principals certificates and for high school teachers, and the committee has debated seriously for the past six weeks, twice a week, what kind of an examination to give. The difficult thing is how to test the power; the results that accrue from laboratory work and which could not be obtained from textbooks. Last June 385 were examined for entrance to the normal schools. When the number is smaller we can take them into the laboratory.

Inspector Clement—I don't know that I can answer the question better than to suggest one or two questions. Suppose we wish to test the pupil's power to observe. Let the student take any flower he chooses, but state in good English how some flower he has studied carefully is able to prevent self-pollination. If he were given a flower he had not observed it might be tyrannic, but let him have a choice. I think that is fair.

Prof. Grout—I don't want to crowd myself on the association, but I want to give just my idea, that I may not be misunderstood. Mr Clement's statements are right as far as they go. The larger part of the examinations still test the memory. Take the question of the flower's self-pollination. What will prevent the child having that drilled into him? Give him a flower and let him tell how it is pollinated.

I realize the laboratory difficulty. What is there in it? It may be difficult but in so far as it is possible, it is my idea of an examination.

Prof. Samuel J. Saunders—I think it will work very well with older ones, but not with children 14 or 15 years old. There is not time to think it out. It will not work with young people in their teens.

Prof. Albro D. Morrill—In teaching biology, I try not to make the examinations wholly examinations in memory, to test not what he knows, but what he can do; to give the pupil a flower which he has not seen and ask him to describe it. I make the memory part of it shorter on the count, give no directions, but simply ask him to make a complete description of it. In some cases I have had very fine results, but not in all. I think I am testing what the pupil can do, and would mark him low for not being able to do.

Prof. Grout—I have tested that in examinations; you have to make the examinations shorter.

Prof. Harvey—The contention is that the student should do his very best work all the time. His results should be the best that he can get. It may be that he has obtained a totally wrong result. That will be corrected and revised when the work is reviewed by the class as a whole with the teacher. The average result of all the members in the class will come pretty near the truth, near enough to indicate the laws.

Prof. Saunders—It came to me when the gentlemen were discussing the values of different methods, one thinking the result should be known and others, that it should not be, the statement that I have seen made that Prof. Tyndall once called Faraday into his laboratory to show him some experiment in polarized light. As he was about to proceed Faraday stopped him and asked what he was to look for. Even this prince of experimenters thought it would be a help to him to know what he was to look for.

In the x-ray experiment spoken of by Prof. Turner of Buffalo, he knew what to expect and what to look for if all the steps were right. The joy came from the fact that all the steps were taken properly.

I think on the other side, answers should be, as far as possible, kept away from the students. I incline to that method. Keep away results entirely till after going through the process, and then compare them with and look through those of others.

Friday afternoon

GENERAL SESSION

THE STUDY OF TYPES

ITS SIGNIFICANCE AND ITS APPLICATION

PROF. N. A. HARVEY, CHICAGO (ILL.) NORMAL SCHOOL

I assume as the basis of this discussion that the teaching considered in this paper is educational in its nature rather than professional. I mean by this that it shall be for the ultimate purpose of training the mind to do better the things that all minds can do in some degree rather than to accumulate a fund of information to be used in the practice of a profession. The psychologic movement of the learner rather than the logical development of the subject is the thing that is of the first importance, and is the chief factor in determining the method to be employed.

Permit me to state also, that in all my illustrations I have had in mind the teaching of science in high schools. If the teaching of scientific subjects in colleges and professional schools were to be considered, the illustrations and the basic propositions would need very considerable modifications.

The greatest contribution of science to education is the scientific method. The scientific method is not a method of teaching, but it is a method of thought, and is capable of universal application. It is called the scientific method because it has been developed chiefly in scientific subjects by scientific men. Its importance is so great and so fully recognized that we are continually finding the scientific method applied to subjects formerly considered most remote from scientific facts.

In its essential features, the scientific method proceeds in an orderly way from the study of an individual to related indi-

viduals. By a comparison of the resemblances and differences existing among individuals, the concept of a class is formed, and thereafter related individuals are grouped into the classes previously formed. By this process we are compelled to recognize the logical sequence and the relative significance of each before we can classify it.

It will be seen that in the scientific method of study, the individual is the first thing to be considered. From this fact the scientific method is sometimes regarded as an example of induction. In reality the scientific method is quite as much deductive as it is inductive, but the starting point is the same as in a case of pure induction. This individual which is taken as the starting point may be called a type, since it always embodies the characteristics of the group that is founded on it. A type, however, may mean much more than the individual that is studied. It necessarily involves all the characters that enter into the concept of the class, but it should be one that contains the average characters of the class. Individuals of the same kind are not all alike; variations occur that make them individuals. These variations are quantitative in their nature, and in some individuals are much greater than they are in others. In any group of individuals that are combined into a class, there will always be extremes of variation and an average point or norm from which variations occur. In the vicinity of this norm will be found the greater number of individuals that constitute the class. It is this average, this point of departure, this possessor of the common characters in the least variable degree that may stand for the type of the class. It will be seen that the selection of an individual to stand as the type of a group is a matter demanding considerable care. It would be very unwise to select as the type for study one of the most aberrant or divergent forms in the group.

It is evident that the selection of an individual to stand as a type will depend on what it typifies. An individual is not a type unless it stands in the mind for a class, or stands as the representative of a group, all of which have common characteristics.

We come at once, then, to classification as an element in scientific study. Classification is implied in almost every operation of the mind above the simplest. It is implied in every act of judgment. Whenever we use a common noun we make use of classification or its result. Every catalogue, every index, every table of contents, the arrangement of our houses and streets attests the necessity we feel for classifying objects. It is a universal process of thought and is common to all human minds. It is this process of classification that constitutes science and makes possible scientific knowledge.

Classification of a series of objects is the actual or the ideal arrangement of those that are alike together, and the separation of those that are unlike. It enables us to do two things. First, it enables us to retain in mind the characters of many objects at once, as well as to infer from things known unknown correlative properties: It is a labor-saving process. It conserves mental effort and this economy of mental effort is perhaps the most important principle in education. It is the thing that largely constitutes the difference between a mind of great power and one of little power.

But classification does more than this. Classification discloses to us the correlations or laws of union of properties and circumstances. It is only when we make a proper classification that these laws appear. We are inclined to think that for every series of objects there is one system of classification that is best, and which we call the natural system, and much energy is devoted to the discovery of that system. The so called natural system of classification in animals and plants is a genealogic system intended to show the relationship by descent of the individuals classified. It discloses the general law of descent and the kinship existing among the different animals and plants. This system is not yet complete, as we do not know enough about animals and plants to adjust them satisfactorily in their places. But there is no question that the arrangement of organized beings in the natural system of classification has been productive of the greatest good in the development of our scien-

tific knowledge, and in disclosing some of the most important and far-reaching truths.

But the natural system of classification is not the only one that may be used to advantage, nor the only one that is still employed in classifying animals and plants. Other systems of classification disclose other laws than those of descent. We still have and still need the classification of geographic regions, of temperature zones, of life habits, of geologic horizons, of physiologic functions. Each of these classifications is necessary and will always be used because each discloses natural laws that constitute an essential part of scientific knowledge.

I think I do not overestimate the importance of the study of classification as an element in education. There are certain elements of dynamic thought involved in classification that are positively fundamental. Somewhere in the life of a student there must be a place where the processes and methods of classification are consciously worked out. If this can be done in one or two subjects, the principle of classification can be applied to other subjects, and be used as a tool to make further acquisitions of power in other directions.

Botany and zoology are the classificatory sciences *par excellence*. Here the principles of classification have been worked out with a fulness of detail observed in no other subjects. Here if anywhere the student must get his knowledge of those principles. In my opinion, botany and zoology must rest their claims for introduction into a course of study largely on the fact that they are classificatory sciences. Any attempt to substitute some other element than classification as a basis for the work in these subjects, is to discard an element of greater importance for one of a less.

I am not unmindful of the fact that both subjects include many departments in which the element of classification is not at all the conspicuous process. Such are the departments of physiology, histology, cytology, paleontology, embryology and ecology. Each of these may be taken as the basis of knowledge of animals and plants. My contention is that in an elementary

course, where the purpose is purely educational, it is highly injudicious to make anything but taxonomy the basis of the work. The other departments are tributary to this and should be so recognized. They are highly specialized departments, and can scarcely be studied in their full significance without some knowledge of the taxonomic relations of the forms used as types. I would take taxonomy as the basis and group around it the essential features of all the other departments, not by any means omit them.

This digression on classification started from the statement that the selection of a type depends on what it typifies. In botany and zoology we have classified groups of different rank, rising through the series of individual, species, genus, family, order, class, branch and kingdom, each with many subdivisions. In beginning zoology, some teachers prefer to begin the subject by studying a grasshopper, crawfish or snail. Others looking to the logical development of the subject, prefer to begin with a protozoon: a paramoecium or amoeba. The reason for the latter preference is that the amoeba is a simpler animal. Looking at it from the standpoint of the pupil who is beginning the subject, it seems to me to be not so. To the pupil the grasshopper is the simpler animal. Smallness is not an evidence of simplicity. To the pupil the grasshopper is the simpler form, because it is more nearly related to the things with which he is already familiar. He is familiar with his own body and organs and their way of acting. The grasshopper has legs and it moves. It breathes and eats. In fact it does many things that he himself can do, and in so far is closely related to himself. It is nearly enough like himself to cause him to feel the similarity and yet sufficiently different to enable him to state wherein the difference exists.

The same thing can not be said of the amoeba. The pupil has no body of related knowledge that can be used in its study, but it stands alone and unconnected in his mind. The development of the subject from the amoeba as a type, does not follow the historical development of the subject, and though this is not

necessarily the best method of procedure unless the historical development of the subject follows the psychologic development of the pupil, this latter is likely to be the case and the historical development of the subject is likely to indicate a logical and psychologic method of introducing the pupil to the subject under consideration.

There are many advantages in beginning the study with an insect or crustacean, such as convenient size, its economic importance, etc. But I have introduced this example to show that all such considerations mentioned really have little weight in deciding on the selection of a preliminary type. We must answer to ourselves of what it shall be a type. A complete scheme of systematic study would lead us to select a type of a species, a type of a genus, a type of a family, a type of an order, a type of a class, a type of a branch and a type of a kingdom. The logical sequence and relative significance of these groups can be determined only if our first animal studied shall serve successively as the type of each. By this process we begin with the individual as an individual and rise by successive generalizations through the less extensive groups to the all-inclusive group of animal kingdom. I know of no one who will undertake, with a high school class, to use an amoeba as a type of a species, a genus, a family, an order, or even a class. It is generally used as a type of animal that is of a kingdom, thus beginning with the most extensive group and proceeding in a deductive order to less extensive, or not obtaining from the subject the content that I should suggest as one of the most important things to be obtained from it, viz, a knowledge of the principles of classification and the full significance of type study.

Besides this, we must decide what an individual shall be a type of before we can decide what characters are of sufficient importance to demand the attention of the learner. An animal or whatever it may be, is at first only an individual, and as such has some thousands of characteristics of which no one will be rash enough to undertake to make a complete catalogue. Different writers of laboratory guides will cause a pupil to see

different numbers of these characteristics, some more and some fewer. A college student will be called on to see 50, and a pupil in the grammar grade to see only five. But on what basis is the number of characteristics to be observed determined? There is scarcely more value in seeing 50 than in seeing five unless the characters to be observed are selected with a reasonable and sufficient end in view. To add to the observation of nonsignificant characters the observation of other nonsignificant characters is an unnecessary waste of energy. They will never become significant.

If we study the grasshopper as the type of a species, we shall notice the carinae, the fovea, and various other things that discriminate one species from another. If it is to be used as a type of a genus, we shall necessarily notice the generic characters: the subgenital plate, the fastigium of the vertex, the prosternal spine and all the other marks by which systematists distinguish one genus from another. In a complete scheme of type study, it seems to me that there might properly be this minute discrimination of characters till the idea of the less extensive groups has been built up.

If our grasshopper is to be used as the type of a family, we shall be called on to see the various family characteristics: the wings, the legs, the ovipositor, and the shape of the body. If it is to be used as the type of an order, we shall notice the ordinal characteristics: the mouth parts, the kind of wings, the metamorphosis. If it is to be used as the type of a class, we must observe the class characters: the body divisions, the number of antennae, the kind of skeleton. If we make it the type of a branch, we must observe the things that separate the branch Arthropoda from the other branches, while if we are to use it as a type of the animal kingdom, it will be necessary to observe independently the things in which all animals agree and in which they differ from all other created beings.

I trust it will be seen that we have here a means and a reason for deciding on the particular characters that are to be observed by the pupil who is put into our charge. The reason for direct-

ing him to such study as will lead him to see these things rather than to see others will not be apparent to the pupil, and I am sorry to suspect that it is not always apparent to the teacher as well. But it is our duty to find the reason for doing as we do or not do it.

I have stated now what a type is, and the principles that shall govern both our selection of the type and the characters to be observed in the study of each. My second proposition is that different things selected as types should be related to each other in such a way that the comprehension of the relations shall not be too difficult for the learner. The types must not be too widely separated from each other and the related forms must be studied. If this is not done there is little value in the study of a type. All thinking consists largely in the perception of relations between things. So numerous and so diverse are the relations existing in the universe that we may say that education consists largely in training the mind to perceive relations. Any mind can perceive some of the most evident relations, but the mind of the greatest philosopher is incapable of recognizing some of those that exist. In order to train the mind to perceive relations, it must be set to perceiving them, and the difficulties must be graded according to the capacity of the mind to be taught. It is in the proper gradation of difficulties that teachers are likely to make mistakes, specially in the teaching of science whose pedagogics is so insufficiently worked out. We have no adequate statement, so far as I have been able to find, of the psychology of laboratory science, and no serious attempt has been made to frame a course of study in science in terms of the psychologic movement of the learner. Our books of method in science are books of devices, or methods in the most limited sense.

Returning to our example of the grasshopper, we have observed the characters that we shall use in studying other animals. We are then ready to take up the study of a related animal. Ordinarily we seek for the type of a family rather than the type of a species or a genus. By a comparison of the repre-

sentatives of different families that are closely related, we can generalize from a statement of their resemblances and differences, and rise to the concept of a larger and more extensive group. Families that are alike make up an order, so we can obtain the concept of an order from a comparison of the types of families. Next we select types of orders and so rise to the concept of a group of higher rank, in which different characters are employed, and are thus seen to be of deeper significance. In a similar way we can obtain in succession an idea of a class, a branch, and a kingdom. If we wish to go into more minute discriminations, we shall be able to reach the conception of each one of the 21 divisions that have been used to designate the successive including groups employed to express the relationships and sequence of animals.

In all this work, our first type may be used as the type of each successive group of increasingly greater extension, for our observations originally included all the characters of the successive types. Successive generalizations separate the table of characters into an increasingly larger table of differences and a decreasingly smaller table of resemblances between the animal first studied and representatives of the more extensive groups. Finally our entire table of characteristics will be seen to be distributed into the successive tables of differences. This process has enabled the teacher to cause the mind of the learner to move in such a way that the relations of the different animals studied have been clearly seen. The mind has been compelled to discriminate, compare, and generalize. Our selection of types has led to this result.

I would not have it understood that we study only the dead forms instead of the living beings, as is sometimes charged against this kind of work. The living activities are just as much a character of the type as the morphologic structures. But the dead body of a beetle is a living thing in the sense that every part has been produced by the life of the animal, and had some function in the life that the animal lived. We study the legs because the animal moves with them; the wings because he flies

with them; the mouth parts because he bites with them. And so it is with every part; each part has some meaning in the life of the animal and it is the object of study to interpret that meaning.

Just here I should like to pause long enough to comment on the value that exists in systematic work in botany and zoology. It is a kind of work that has of late fallen very much into disfavor, and very properly, too, in consequence of the great abuse to which it has been subjected. The marks that are used to discriminate genera and species are apparently so trivial that they seem ludicrous. I would merely suggest that the variation in physiologic function and life habits is usually much more pronounced than it is in the morphologic structures. But the differences in morphologic structures can be quantitatively stated and used to discriminate species. Even among individuals of the same species such variations in personality exist that we need to study many individuals of the same species in order to obtain an insight into the psychology of the mind of the species. Also, I would suggest that all the most delicate work of the embryologist, the histologist, the ecologist, everybody who contributes to the knowledge we possess of an individual of a particular species, only helps us to arrive at a better understanding of the relationships that exist among the various groups of animals and plants, which is precisely the thing that the systematist attempts to do in a rough and ready way.

My third proposition is that the study of types is necessary for the purpose of economizing effort. This is merely a corollary to our discussion of classification. I doubt if there is a more important principle in education than the one indicated by the phrase, economy of effort. I believe that it can be shown that the essential difference between the great intellect and the common one is embodied in the phrase, economy of effort, and that the most important mental processes are those that most efficiently conserve mental work.

A type from its nature stands for a class. Everything that we may predicate of the type as distinguished from the individ-

ual, we may predicate of the class. We need not then examine all the members of the class in order to know what its properties are. Type study is a substitute for perfect induction, and while it has serious limitations, its advantages are very great in the economy of effort. The great extension of knowledge in every direction has necessitated a development of some method of using it. Otherwise it becomes unwieldy and a student is overwhelmed by its very profusion. Type study is the method by which this great wealth of knowledge can be acquired and made available for service.

The idea of a group that will include the various individuals studied is obtained by a comparison of their properties and selecting from the entire number those in which the individuals agree. The concept of the more extensive group is obtained by observing the resemblances that exist among the types of the less extensive groups. This process is called generalization, and is of essential importance. In fact, most of the other operations of the mind may be regarded a tributary to this one function. It necessitates a good many preliminary operations: abstraction, analysis, discrimination and comparison.

The perception of resemblances is a more difficult process than the perception of differences and manifests a higher order of thought. There are acute minds that have in a marked degree the power to see differences, but whose ability to see resemblances is exceedingly limited. In order to generalize we must often see a logical identity existing in objects that on first examination appear to be wholly unlike. Paradoxes are fused into a unity, and things that seem to be so diverse as to render the assertion of their identity absurd, are seen to be essentially the same.

Every mind must generalize, and has the power so to do. But the differences in this power possessed by different individuals are very great. It is a power that can be exercised safely only with much caution and after long training. Every great advance in thought has followed a wider and more far-reaching generalization. Those who are capable of making such general-

izations are the philosophers and leaders of thought. In natural science we are taught consciously how generalizations are made and the necessary cautions to be employed. Science, then, is the great training ground for those who generalize, and from the ranks of scientific men, or those trained in scientific methods, the philosophers of the future are sure to come.

In the collection of material, the mind becomes buried under a mass of details. We must select out of this mass particular things that we can examine fully, and generalize from them. The selected forms are types, and their inspection is necessary to enable us to generalize.

My fourth proposition is derived from the third. Economy of effort is obtained by comparing the second type studied with the first. It will be remembered in our previous illustration that the elementary type, or the first form studied, was examined as an individual. There is no economy of effort if the second type is studied *de novo* in the same way. It must be studied by comparison with the first. Ordinarily, its individual characters need not be noticed, but only the specific and generic characters. That is, the characters that are like or unlike those selected for study in the first.

The former practice in beginning the study of botany was to learn lessons from Gray's *Botany*, and after they had been well memorized, then to go to the flowers and apply to them the names of the parts that we had learned in the lessons. That is the way that I began the study of botany. While I have a profound respect for Gray's *Botany*, I have not so much for the teachers who used it in that way. They failed entirely to grasp the significance of type study.

Suppose that we decide that it is a proper part of botany to study flower structure. If one of the buttercups is available, it will serve well as a type. A short time will suffice to fix the fundamental characters of this flower. The evening primrose in the next lesson will embody the same essential elements of flower structure with modifications, the most important of which is the fact that the ovary is compound. The compound

ovary is about the only thing in the flower that must be learned new, and this is learned because it is a difference from the type form of flower previously studied. A study of the jimson weed will introduce us to the monopetalous corol; a clover to the papilionaceous corol, the diadelphous stamens, and the clustered head. Other ideas in flower structure can be simply exemplified by a proper selection of types, so that 10 lessons treated in the most economical way will give the student a better idea of flower structure and plant morphology than we obtained in three months in the old way.

It was formerly the custom, now happily abandoned, in studying flowers to have a series of blank forms with many descriptive words, and the pupil was expected to underscore the words that fitted the flower he had in hand. You will see that in this process each flower was studied by the same pattern that the first one was, so that there was no economy of mental effort, though there might be a saving of ink in consequence of not having to write the descriptive words.

By the use of properly selected type forms, it is easily possible to study a dozen related individuals with no more effort than it took to study the one used as the original type, and do it as well. I have often observed that a class in the first year of a high school course will learn as much about a cricket, see just as many characteristics and see them just as well in two days as they saw on the first specimen studied, a beetle or a grasshopper, in five weeks. A common explanation by unthoughtful persons is that the powers of observation are cultivated by the study of natural science to such an extent that they have become able to see more in a given time. The power of observation as a reason for studying natural science has been so much overworked that I always feel suspicious of either the knowledge or the sincerity of anyone who gives that as a reason why natural science should be studied. The power to observe comes largely from the related facts previously known.

My fifth proposition is that type study is almost universal in its application. It is a conspicuous feature of the scientific

method, and is capable of application with all its advantages wherever the scientific method can be applied. I have been using illustrations drawn from the classificatory sciences, but it is now being applied to geography in the series of books of which our friend Dr McMurry is one of the scholarly authors. In sociology my friend Mr Thurston is enthusiastically using it as a great improvement over the former method. In literature we see the same thing in progress. Everywhere we see the same tendency manifested. In fact, type study is not a thing just newly discovered. It is a very natural thing and has been employed deliberately many years. It is only recently that we have awakened to its full significance and have begun to inquire into its real merits and to study the laws that determine its use.

There is one other consideration that ought to be noticed. Type study presupposes that an individual is the center of correlation for all the characters that pertain to it. Now suppose that we had all the observed characters of one type written in a vertical column under the name of the type. Beside it we have the name of another individual or type with all its characters written under its name. Similarly suppose that we have the observed characters of several or many types written under their respective heads. Now shall we study our tables vertically or horizontally? Shall we make the type individual the center of correlation or shall one character expressed in the table be the basis of our study? Shall we study how the bumblebee lives and moves and has its being, what organs it works with and what kind of a creature it is, or shall we study how animals defend themselves and notice the bumblebee's sting as a defensive organ? The latter practice is directly opposed to type study. The advantages of type study are so pronounced that I have no hesitation in saying that the individual ought to be made the basis of study, but, in consequence of the natural disposition of people to run after strange gods, I believe that many people overlook its advantages and try to make an abstract principle the center of study. I grant

you that these generalized principles must be known, but they become known so easily and with such great educational benefit when several types are studied and compared, that it seems to me a serious matter to abandon type study and make generalizations already worked out the basis. Such things are very well for newspaper science and cheap magazines and popular lectures, but they can never constitute the core of a scientific education.

Dr Grant Karr--*Mr Chairman, Ladies and Gentlemen:* We have listened with great interest to Mr Harvey's paper. I have enjoyed it to the extent that my knowledge would allow me to grasp it. I appreciate the fact that Mr Harvey is a specialist in his line, and this paper is one we will read with pleasure and profit hereafter. It seemed to me very difficult to get hold of it as he read it, and since I did not have an opportunity to read it and did not feel disposed to prepare a set paper and go off perhaps on a different line of thinking from that which Mr Harvey would take, my preparation is not very extensive, and what I have to say will be more in the line of suggestions, that have occurred to me and will pertain more to the teaching of science in grades below the high school, those being the ones with which I am most intimately acquainted.

The paper impressed most deeply some suggestions made this morning in the paper read by Prof. Saunders and its discussion. The first question which occurred to me was this: What is the relation of scientific knowledge to practical life? That is to say, what is science to do and why are we teaching science? Is the mere knowledge of scientific facts the end and aim of science teaching? That of course would bring up the whole discussion that arose this morning regarding examinations. There is a pretty well settled notion in the minds of many that an examination in any subject finishes it, and any preparation, in science or anything else, that would enable one to pass an examination, Regents or college entrance, suffices and that the passing of such examination *closes* the case.

Prof. Harvey in several places intimated that his solution of the question would be somewhat different; that he would have a knowledge given in science that is not of the sort that can be exhibited in answer to certain questions, a knowledge deeper than that, a knowledge that enters more deeply into the thinking, feeling and willing of a person, like the knowledge that was referred to this morning by the gentleman from Buffalo when he was first successful in making a photographic plate by means of x-ray, of a bullet that had lodged in a person's hand.

I would be glad if someone would discuss more fully and throw more light upon Prof. Harvey's treatment of this phase of the subject. It seems to me that the thought underlying his discussion more than anything else was that of the laboratory as a means of giving the student the requisite experience as a basis for thinking, doing and living. His first statement was that he wanted to call attention to those things which all people do, and which only the few do consciously and with a goodly degree of accuracy. The scientific method has come to stay and is a necessary part of the equipment of all who expect to understand the life and doings of the 20th century. The idea of evolution has come into the world and is influencing all sciences and all phases of life whatsoever, religion, literature, history and everything else. Someone has said that the two ideas of sociology and evolution are the two ideas by which we measure the present. They are the dominant ideas which define the present. Everything is filled up with these ideas. They are treated of in science and the scientific method is permeated with them so that one of the results of science teaching, as Prof. Harvey says, should be the acquisition of skill in the use of the scientific method.

What Prof. Harvey has said regarding the nature of classification strikes me as very excellent indeed. The nature of generalization and classification is best understood in this relation, types and type study being their less complete form, a sort of going from the less intricate into the more intricate and abstract ideas which the cut and dried statements of the science

books give us. It seems to me good for us to have our attention called to the fact that there is no absolute knowledge on science, or any subject, for that matter. This "big buzzing blooming world" exists everywhere, varying in clearness and confusion, in every kind of knowledge as in science, and the study of types is a natural way of approaching to a more or less complete comprehension of it, more perfect by far than out of a textbook.

The study of types, it seems to me, is also the natural approach to the gaining and organization of knowledge, that is to say, it gets at the general idea tentatively in each animal or in each species of animals, which underlies a certain class and their functions. Types are a sort of nascent generalizations.

One practice Mr Harvey did not mention, that is sometimes to be found among science teachers, in the lower grades specially, is that of treating science or nature facts as a hodgepodge of isolated sensuous phenomena. That is to say, the experiences of the pupils are a sort of fireworks, a series of sensuous experiences the relations of which remain for the most part unemphasized and undiscovered. Such work is utterly unprofitable. A certain amount of classification must enter in if the work is to be valuable, no matter how elementary the grade is in which nature is taught. There must be some classification, varying with the maturity of the students, of course. A few characteristics seen together form a type. That is the way mind works. The mind can not make any movement at all without making a judgment, always something is something, the less general often the more general. It is the "logical way" which the mind always has. The study of types takes into account the mind's natural way of moving. Hence its excellence. Study the cat. One of the good things is to call attention to its definition, perhaps ask the question, "What is a cat anyway?" There comes in the necessity for a loose classification, the formation of a type. One can not tell what a thing is in any way without relating it to something, and so the type becomes a nascent generalization. I have tried the experiment several times in all grades. There was much difficulty at first in defining the thing,

but yet a welcome difficulty because it appealed to power in a natural way. If attention has not been called to it before, it makes the subject more interesting than it otherwise would be.

Oftentimes, always in the higher grades, one has to take into account the experience the people have had who are being taught, and give the experience, put the people through a course of living before they get anything to classify, in the form of types or otherwise.

As to the newness of type study, I suppose that people who have studied, who have gone into the make-up of things, have always been driven of necessity into the study of types, and that with the rise of the study of natural science this type study has become more and more prominent. The rise of evolution at the close of the 18th century, for instance, gave it more prominence, and led to a new reformation. The facts that Aristotle began classifying and his nomenclature of science were only type study in the light of 20th century science. The classes of Aristotle and those who preceded and followed him were really a sort of world historical study of types. One might call every outlived scientific system of classification a fossil system of types, e. g. the systems of Linnaeus, Cuvier and others.

One more point that occurred to me here in this connection was in regard to the nature of knowledge. It is often regarded by many, and I think that most of us who are engaged in teaching are often haunted with the assumption that knowledge exists somewhere outside of us and it is talked about as if its facts could be gotten out of a textbook or laboratory and placed in the mind analogous to the way in which physical objects might be gathered and dumped into a receptacle. This is an utter failure to understand the nature of knowledge, and such a view, if one has it, is sure to result in more or less superficiality. Knowledge is not a thing that can be "put in" by the laboratory method or textbook method. It must be produced inside. The theory side of the idea is not all there is of it. The mind is more than ideas. There is action and feeling. If the other side of the knowledge is not there, it is an empty knowledge. The labo-

ratory will enable one to take on more of this external knowledge than the mere textbook, but yet it seems to me that the laboratory should be used to widen the whole experience of a person, to give him deeper insight into the life that he has lived and at the same time aid him to live a larger and fuller life. The laboratory is one of the most potent factors in the progress of the last one hundred years. But would it not be still more powerful if it were brought into closer relation to the other sciences and life itself? Are not the laboratories themselves too often satisfied with mere knowledge as a result? "Life is more than theology (theory) and the people know more than the preachers (whatever method they may have) teach," says Emerson. But this brings up the whole question of the subconscious in our life, and its understanding involves a full discussion of epistemology and its bearing on practical life.

Prof. C. W. Hargitt—I have been interested in the presentation of the paper, and while not caring to enter on its discussion at this time, thought, however, I should like to ask Prof. Harvey a few questions. I don't know that they would be profitable questions here, and yet they may: whether pedagogically speaking he should consider the type method of approaching the profounder or broader subject of taxonomy, indispensable in all grades of work. I suppose that if we were to speak of it from the high school standpoint alone, and I think that was his point of view largely, there might be some fair unanimity of thought. If we were to speak of it from the point of view of the grammar school teacher in the sort of work the grammar schools are able to do which we recognize under the head of nature study, might not something very different better serve the aim of science work, and when we come perhaps to pass into the more intricate problems of morphology and embryology in the college course, might there not be some differences of opinion, honest and serious, as to the type method? After all, it seems to me that more will depend on the individuality of the teacher than on the method. Let the teacher possess himself or herself of an ideal and a purpose and it makes less difference what the

method may be. There may be very little of method in certain cases and yet admirable results. I thought this morning during a part of the discussion, when it was stated that an expectation of what was to be found in the dissection of animals gave zest to the dissection, that such was the method of no less distinguished a teacher than Huxley; and Huxley's introductory manual for laboratory study continued to be a type of laboratory method for nearly a generation. There has been some wide departure from that method of late, and yet the method that produced the results that were produced through that means is not to be despised. If, on the other hand, we take the other extreme and take Agassiz as its exponent, who, after handing a starfish to a student and letting him work at it, and asking him what he saw went off and let him look at it more, and so on for a day or a week, without a word of specific direction, that is another method.

We need only to refer to the products of the method in the men who have come from Agassiz's inspiration, as sufficient proof of its value. Whether the type method or some other method shall be used depends largely on the temperament and point of view of the teacher; and after all, the teacher is the motor in all this laboratory instruction and in all science work. Were it not so, let us use encyclopedias and textbooks and all that. They are a great deal cheaper than teachers; don't require much apparatus, nor care of apparatus. Let us turn them into encyclopedias and dispense with the live teacher. In the presence of the beginner, the child in the kindergarten, or in the grammar school, or even the boys and girls in the high schools there is something that is fundamentally important in life as it expresses itself, not only to see the form and structure of the thing, but how it acts, to move the leg or wing or jaws, to see it in its natural environment and doing the things that belong to it.

I do not know whether the association want to take time to discuss these questions suggested by the paper, but I would like to know, and perhaps the association would like to know,

whether in these three or four grades of science work the type method is the necessary preliminary to all sorts of students.

Prof. N. A. Harvey—The second paragraph in my paper stated that it was written with high school work in mind. If other phases of the work were to be considered it would need considerable modification. This method of type study will be applicable only when the things desired to be obtained from the study are approximately something like what I have suggested here. I do not conceive that this is the purpose entirely nor very largely in nature study work, so called. The use of the term method, we sometimes think, implies some particular process of doing something. That is not the thought in my mind. My thought is that method is not something that can be patented, but that method depends on the content of the subject, the way you wish to make the mind of the child move. In certain schools and colleges, as I look at it, there is an entirely different purpose in view from that suggested. In professional schools particularly, the purpose is to obtain the largest possible amount of knowledge concerning the things that have to be used, in the shortest possible time. Books are used to the fullest extent. Books, lectures, laboratory, travel and anything that can conduce to the rapid acquisition of knowledge is to be used to the fullest extent. The college student in most cases is beyond the stage of developmental work that I have described here. He may be considered as having passed through a large part of the work. If not, he is a preparatory student and not a college student in the legitimate sense. He approaches the second phase of scientific study, which is largely a reading phase. He wishes to become familiar with what other people have said and done in the work engaging his attention. When a student reaches the limit of knowledge on the subject, learns to use his tools, knows what has been said and done with reference to his particular field of work, this little bit of the scientific world that he has mastered for himself, he proceeds into original research work and adds to the knowledge which the world possesses. That is the difference as I

see it. The method depends entirely on the movement of the mind that the teacher or the instructor desires to have the pupil make.

Prof. A. P. Brigham—Not very long ago I heard one of our most eminent physiographers express the opinion that the time would come when we would get the land forms due to river action, for example, as fully classified as we classify the forms covered by the sciences of zoology and botany. I do not agree with that. I do not think the time will ever come, and I pity the teachers and students when it does come. I hold indeed that land forms are capable of a good measure of classification. Dr McMurry would tell us of his use of types in geography. I will make a suggestion or two. One form of the land is known as a mountain. How would you teach what a mountain is? No definition would cover mountain, so I am inclined to think we would have to begin with the study of types. We can not bring mountains into the schoolroom. If I could have my way, I would bring over the Jura as a type of folded mountains, not much worn, as the simplest type of the mountain form with its foldings, and see how these are made, and then compare the Appalachian, I mean in the narrower sense. I leave out the Adirondacks, as their structure is hypothetic; leave out the Green mountains, taking the simplest part of the Appalachian system as found in Pennsylvania. Then I would give a great deal of time in comparing the old and worn out Appalachians with the Jura.

If I were in Denver, I would begin with the great western system, taking the Rockies for a start. Teach the Rocky mountain structure as it is known. Go on to the Wasatch mountains or take the Sierras and Coast range, associating the plateaus with them. The order would not be very essential, but we can all see that, as we have passed from one mountain group to another, we should be saving time in all cases, and come out with some kind of a definition of mountains.

There would be other forms of the land, giving the same rational use of types. Let us take volcanos, beginning with

Vesuvius. That is as good as any. Learn all we can about it, and then we may take up almost any other in comparison, Etna for example. Then go over to Hawaii and note the differences in lava, form of cones and manner of eruption. Then pass to other types of volcanic activity.

I agree most heartily as to the great saving of time and energy, and on the idea that we come out with good general notions. I am very sure that our principles grow by using the type method in geography.

Prof. Harvey—*Mr Chairman:* I have had my say. I have made my speech. I do not know that I have anything further to add. I stated in the paper that the study of types is not new, but newly applied. I think it is being applied to the study of geology, as Prof. Brigham suggested, in a way that it has not been done before. No one has undertaken very long ago to study the forms of the land as type forms, nor to work out a typical land form. An examination of almost all the geographies at present used will show that they are studying type forms, instead of individual objects without relation to other individuals that may be grouped with them.

I think the study of types is coming to be used in a new sense from what it has ever been employed before. One thing I should like to say in addition, with reference to some remarks made by Prof. Karr. It may be well to state the relation of knowledge to what may be called discipline. It has been said that there is a contradiction in the two terms. I believe that there is no contradiction but a harmonious relation between them. It is clear to me that we may have the knowledge without having caused the mind to go through the processes that result in strength and power, and we may have it without any acquisition of power in the getting, but there can be no getting of power, training, discipline and improvement of the mind without a concurrent gaining of knowledge. An examination, if a teacher chooses to give it at the end of a term's work or the conclusion of a study, tests the knowledge. If the work has been properly done, the knowledge gained may be taken to measure the power that has been gained, though the knowledge and the power are not identical.

Knowledge may be tested without testing the power at all. The acquisition of knowledge necessarily accompanies the gain of power, but the gaining of knowledge does not imply that power is gained in the same process.

Prof. Hargitt—It may be of interest to the teachers of physiology to see some of the experimental work and the models illustrating the experimental work done with the first year students in physiology here. The laboratory is at the west end of this corridor, just opposite the head of the stairs, corresponding to this room, and tomorrow morning, between 9 and 10 o'clock, a demonstration will be made of heart action. Anyone interested in that work will be welcome to see the models and the experiments. They are rather ingeniously arranged, and very strikingly illustrative of certain processes which are not often seen.

Friday afternoon

SECTION MEETINGS

Section A. PHYSICS AND CHEMISTRY

PREPARATION AND TRAINING OF THE TEACHER OF PHYSICS

PROF. CHARLES B. THWING, SYRACUSE UNIVERSITY

There are, I believe, three classes of men engaged in teaching.

First, those who are aiming at some other profession and are teaching as a temporary means of support. I presume that the number of this class engaged in teaching science is comparatively small, and that the number so employed who take sufficient interest in the broader aspects of the teacher's work present today is smaller still. I shall not have them specially in mind, therefore, in what I shall have to say.

A second class is comprised of those who have no special aptitude or preference for any other calling and have therefore taken up teaching. Their idea of teaching is somewhat like the coachman's notion of the episcopacy. "For a nice, clane, aisy job," said he, "give me bishop." I may say in passing for the benefit of visitors who may not be teachers, that the "job" of a success-

ful physics teacher is neither clean nor easy. It means long hours, dirty hands, tired back and weary brain. But to him who loves his work it is a task full of pleasure and rich in rewards.

This leads me to the third class, which, I need hardly say, is composed of men who *could* do other things, profitably to themselves and acceptably to others, but who could hardly be contented anywhere else than in the teaching profession; men who are *called* to teach, called by their inclinations and aptitudes to begin, called by the loving appreciation of pupils and the commendation of principals to continue a work which they find, despite long hours and poor pay, brings them the consciousness that they are doing a work, quiet and unheralded though it be, the influence of which in molding the characters of the rising generation is second in importance to the work of no man, however prominent he may be in the public eye.

For the younger teachers present I shall try, in the time allotted me, to sketch in barest outline the ideal teacher of physics. In the discussion which follows this paper I trust the more experienced teachers will fill in some of the details of the picture till we see before us a composite portrait of the best science teachers we all have known. It will then remain for each of us to compare ourselves with our ideal and devote the remainder of our lives to completing our training and preparation for our chosen work.

The teacher of physics is first of all a man. His first concern for himself is that he may be a clean, honest, upright, manly man, whose interest in his students is not confined to the classroom but includes their sports and recreations, their home life and reading, their other studies and employments. He sees in each pupil, not primarily, one of a class to each of whom the same task is to be given, the same goal set, but an individual human soul, struggling with his own peculiar difficulties, often ignorant of his own needs and limitations, yet always open to help from the man wise and kind enough to see and show him his needs.

To the true teacher his subject is but one, perhaps his best,

avenue of approach to the individual student's inner self. It often happens that the teacher's first real approach to the student must be along lines outside the subject taught. Every teacher will bear me out in the statement that he who has once found the way to a pupil's heart can teach him something about any subject which he himself has mastered, however long or deep seated the fancied dislike of the student for that subject may have been.

The youth retains to a large extent that insight which is so marked in young children. He knows his friends. No simulated interest in his affairs, no attempt on the part of the teacher to hide his own defects of scholarship or vices of character can long deceive the pupil. The man who hopes for permanent success by any but the most open, honest methods of dealing would better follow some employment which brings him into contact with grown men whose confidence in their judgment leads them to distrust their intuitions. He who probes men's souls like the surgeon who probes men's bodily wounds must have clean hands and instruments, or he will do more harm than good.

Second, the teacher of physics must have the same qualities which make the teacher of any other branch successful. He must be master of himself under the scrutiny of bright eyes, eager for knowledge or mischief, looking from the same bench with eyes whose attention must be caught and held till the sluggish, wandering thoughts are focused on some worthy object. All that any teacher needs of tact and skill and patience the physics teacher needs, and sometimes, when the apparatus goes wrong and the experiment falls flat, he is likely to feel that the humility of Moses coupled with the patience of Job would hardly be sufficient to preserve his equanimity.

The graces of tidy dress, a cheerful manner and a pure, clear English diction should be his, whatever effort it may cost to gain them.

Again the teacher of physics is a teacher of natural science, and the different sciences have relations with physics so close that it is impossible to ignore them. Indeed if the student has

before studied and become interested in another science, the interest already aroused may be carried over to the new subject by an easy transition along the lines of contact between the two. If the teacher knows less of these kindred branches than the student knows, or thinks he knows, there is danger that the student will underrate the teacher's knowledge of physics. If, on the other hand, the teacher is fairly well at home in the other sciences, he can, by skillfully drawn illustrations, bridge the gap from the known to the unknown and lead the student to a firmer footing in the new territory.

I believe no mistake is more commonly or more often made by young teachers than what I may call, for lack of a better term, the error of abruptness. We plunge the student up to his eyes in a flood of new terms, new ideas, new methods of thought and then wonder that he gasps and flounders helplessly about instead of swimming easily to solid ground. We ought rather to conduct him to some point in his present groundwork of facts from which he may pass by easy stepping-stones across the boundaries of the new.

I am sorry for the teacher who is compelled to teach half a dozen sciences at once without time or adequate equipment for any one of them, and yet I am convinced that if the opportunity offered for the teacher who intended ultimately to teach physics to spend a year in teaching chemistry or biology or astronomy or physical geography it would be wise for him to embrace that opportunity and make the most of it. Physics is preeminently the broad or basal science. It now compasses the major part of what was once called natural philosophy and it is still the most general of the sciences.

If we think of natural science as one of the great natural divisions of human thought, physics occupies a mountain range and table-land near the center of that realm. In the foothills, well within the boundaries of physics, lies chemistry, in a territory which remained fairly well defined so long as the physicist kept himself strictly to masses and molecules and left the atom to the chemist. But of late years the chemist has been making

incursions into physics till a neutral territory called physical chemistry has been formed. Still more recently the study of Röntgen rays, Lenard rays and kindred lines of investigation have compelled the physicist to believe that the atom is not, in reality the ultimate division of matter, but that the atom itself consists of thousands of smaller particles which Prof. J. J. Thomson calls corpuscles.

The physicist and chemist are, therefore, constantly crossing each other's territory, and he who is the trusty guide in physics must know at least the landmarks in the realm of chemistry.

The ultimate nature of matter, electricity, gravitation and the other forms of energy are the almost unexplored peaks which lie at the center of the field of physics.

Biology is a sunny land lying to southward. Its denizens trace back the streams of life to a point within the boundaries of physics and chemistry and leave us to track them still farther toward their ultimate source.

Geology overlaps with physics on the one side and biology on the other.

All of the sciences are debtors to physics for their instruments of research and all assume the fundamental laws of physics and chemistry for a working foundation, as physics in turn assumes the laws of mathematics. In view of the intimate relations which exist, therefore, between physics and the other sciences it behooves the teacher of physics both to include a study of these sciences in his general preparation for his work and to keep up as far as possible with the progress being constantly made in these subjects.

For the latter purpose I feel hopeful that a publication recently begun known as the *Current Encyclopedia*[1] would be of great value to every teacher. The science department of the *Literary Digest* is exceedingly helpful along these lines, though more popular in character than the first named publication. Both of these periodicals contain, of course, much other matter

[1]Modern Research Society, 153 La Salle st. Chicago.

of interest in other lines than science which for the sake of general culture the teacher might profitably read.

I come now to a matter which may seem to some of you not quite germane to my subject. I am, however, unable to separate it in my own thinking or to keep it out of my daily teaching. I refer to the relations of science to theology. That any conflict has existed between science and religion I do not believe. I can not conceive how an increased knowledge of the laws of natural phenomena can in any wise diminish our reverence for the divine first cause, or lower our ideals of duty toward our fellow man. Indeed I think no thoughtful person ever contended that men of science are less reverent, less law-abiding or less abounding in good will and good deeds to their fellows than are other men.

Science has, however, attacked again and again certain beliefs which were so closely connected with religion in the teachings of the church and hence in the popular thought, that religious teachers took alarm and the truth was in danger of being lost to view in the smoke of noisy conflict. The field of battle shifted from geology when the old interpretation of the meaning of the days of creation had been abandoned to biology, which with the doctrine of evolution struck a stinging blow at the popular beliefs concerning the origin of man.

A question which it is to be hoped may be debated with less of acrimony than either of these because of a growing spirit of tolerance in both camps is the problem of the origin of life. That problem must find its solution, if the solution is found in physical science at all, in the realm of physics. At present the biologist is tracing back one vital phenomenon after another to the point where he can say, "It is explainable by purely physical or chemical processes." Suppose now it be found that the movements of the lower forms of animal life may be induced by electrical or chemical means, and do not necessarily argue an intelligent purpose on the part of the animal to seek its food, does the acceptance of this explanation preclude the necessity for a guiding intelligence in nature?

A recent case in point will illustrate my meaning. It is a well known fact of physics that, while the shape and position of a large body of liquid is determined chiefly by its own weight, the shape and movements of small drops and films are determined almost wholly by what is called capillarity or surface tension, the force which gives the raindrops and the soap bubble their spheric shape and causes the oil to rise in a lamp wick. Now a German scientist has lately found that he can by whipping soap suds in oil produce a filmy froth which presents under the microscope the exact appearance of protoplasm, the physical basis of life. More wonderful still, this artificial protoplasm creeps and moves about and its individual cells contract and change their shapes and have currents of fluid circulating within them in a manner startlingly like the behavior of protoplasm itself. The so called "life" of the film is about 22 hours, after which it loses its power of motion and disintegrates.

What has the physicist to say in answer to the question, "Does surface tension explain the life of protoplasm?" To him the crucial point of the experiment is its end. The movements of the artificial protoplasm ceased when the energy imparted to it by the experimenter in the whipping process had been expended. It had no power to draw energy from its surroundings and so keep itself alive. If there is one law of more universal application than any other it is the law of minimum potential energy. In accordance with that law all spontaneous motion in dead matter is in that direction which will result in changing its condition from the less stable to the more stable. Water flows down hill, escaping steam expands, complex unstable chemical compounds, such as those formed under the influence of life, disintegrate or decay to stable compounds when left to the unhindered operation of physical forces. The heat of the sun itself is being radiated through space and the sun and all the planets must one day be as cold and lifeless as the moon is now. Nature, so far as physical and chemical laws can determine, is slowly but surely running down to a dead level of equilibrium. For the soap protoplasm there was noth-

ing to do but die. It could not generate other soap protoplasm, nor even keep itself alive. It had no resources other than the mechanical laws of physics, and these, as we have seen, always lead to the same end.

But the plant protoplasm does otherwise, it draws energy from its surroundings and keeps itself alive. It generates other protoplasm like itself and builds up a living organism, differentiated in its different parts, employing the principle of division of labor as if working toward some definite end. It overcomes the chemical affinity of stable compounds in the soil and builds them up to highly complex unstable compounds. It overcomes the force of gravity and lifts a ton of wood a hundred feet into the air, building a tree which lives a century, surrounding itself meanwhile with a whole forest of trees which are, like itself, fighting against wind and flood and the subtle forces of decay. Whence has it the power to do all this? There must be something in or about or with the protoplasm that makes for progress in opposition to the inexorable laws of physics. The question "What is life?" remains unanswered, but the stream of life has been traced one stage nearer to its source with the result that the presumptions in favor of a purely materialistic origin of life are fewer today than at any time in the history of modern science.

But, someone asks, would you think it wise for the average teacher to speculate on these questions before his class? Possibly not; that is a question for each one to decide for himself. The average teacher will have young people in his classes who are thinking somewhat on these questions, thinking oftentimes with the deepest concern, for young people often take the deep questions of life more seriously than do their elders, and those same young people might be greatly helped by a thoughtful word spoken in private.

At all events one thing should be desired by the teacher above all others, both for himself and for his pupils, I mean the attitude of mind which places truth above everything else, that humble spirit which keeps the mind open to truth from every

source, that spirit of reverence toward all truth which never scoffs at what it can not comprehend, nor willingly distorts the truth to gain a point in argument. The man who by patient thought and honest life has won his way to such an attitude of mind may never attain a wide grasp of philosophic problems himself, but among his pupils there will arise men whose thought will mold the forces of the world for good.

Last, the physics teacher is to teach physics, a task which requires for its successful fulfilment certain special aptitudes and habits of thought and a fairly definite technical equipment. Physics is, at least in its possibilities, the most exact of the natural sciences. The phenomena studied admit of accurate measurement and are reducible to laws which may be expressed in mathematical symbols. The physics teacher should have or seek to acquire, therefore, the habit of accuracy of thought. This habit will show itself in speech by the employment of exact terms and by the frequent use of such qualifying words as "about" and "approximately." It shows itself too, in habits of promptness, order and neatness, and in manipulative skill, for the difference between a successful experiment and a failure depends oftentimes on a turn of the wrist, while the ability to give the wrist the right turn at the right moment tells of a habit of accuracy which has taken years to gain.

The physics teacher needs to have a taste for mechanics together with some practice in the use of tools. Few pieces of apparatus come from the maker in perfect adjustment and fewer still will stay in adjustment from year to year. The teacher who can use tools is rich with a very meager outfit if he can command a small fund from which to buy materials, while the clumsy teacher would be poorly off with a costly cabinet of apparatus at his disposal. The fundamental laws of physics are grounded in mechanics and find their illustrations in everyday machines. The teacher of physics should form the habit of noticing machines of all sorts and trying to understand how they work. I spoke near the outset of the opportunity afforded by the student's knowledge of other sciences to introduce him to

the study of physics. It often happens, though, that the student has no such knowledge to help him. There are few boys, however, who do not have a working knowledge of some machine and most girls understand the working of the sewing machine at least.

A little broader field of observation and one which the teacher may cultivate with pleasure and profit all his life is found in the daily experiences of common life. A glass of water and a spoon at the dinner table afford illustrations of reflection, ordinary and total, magnified and diminished images by reflection, refraction, magnification by refraction, water waves, sound waves, and many other phenomena, while daily observations of the weather and of the varied out-of-door phenomena which daily crowd themselves on his notice will give the teacher a fund of facts for illustration such as no amount of reading could afford. I call to mind a drawing in a well known textbook of elementary physics which is intended to illustrate the apparent position as viewed by a person in air of an object under water. The man who drew the picture was an experienced teacher of physics, but neither he nor any one else ever saw the like of what he has there portrayed. There are two ways in which the teacher might have guarded against the possibility of making an error of this sort. One is the habit of observation just mentioned, the other is a study of the subject as treated in textbooks of a higher grade than that used in the class. Just here a word of caution is necessary. While advanced methods of treatment are valuable, I may say necessary, to the teacher for a thorough mastery of the subject, he must beware how he presents to his elementary classes any but the most elementary methods. The methods of trigonometry or calculus may appeal to the teacher by their clearness and simplicity, but to the student who has at best but a vague conception of geometry these are an unknown tongue.

The teacher should bring to the class the results of his study, not the steps by which he has reached them. Physics is strong

food for babes. It must needs be predigested in the teacher's mind before it can be profitably offered to the pupil.

This work of mastering and simplifying the principles of so difficult a subject is the work of years, and it can not all be done before the teaching work is begun. Day after day, year after year, the teacher must modify and adapt his methods of presenting the subject till he has several good ways of explaining each point all at his tongue's end, and even then he will some day need to extemporize a new way in the presence of the class. It is for such emergencies, the propounding by the thoughtful, observing student of some question which seems never to have been asked before, that the teacher should be constantly trying to prepare.

If to all the qualities that I have suggested the teacher can add the ability for original research, he will bring to his class an added stimulus that nothing else can give. But here, too, let him beware lest he ride his hobby to the detriment of those who need a broad training in the subject as a whole, and a training which deals with the foundation principles of the science with such illustrations of those principles as will appeal to the student in his present state of knowledge so as to connect the facts presented with the facts already his, and thus to give him that toward which all education aims, the mastery of self in his manifold relations to the world in which he lives.

This is the end I have had in view while outlining the chief phases of the physics teacher's preparation for his work, which I may now, perhaps, best summarize in the inverse order of their presentation.

1 The physics teacher should endeavor to attain to as accurate and broad a mastery, both theoretic and practical, of physics itself as lies within his range of power and opportunity. This presupposes a corresponding mastery of mathematics and implies some skill in practical mechanics.

2 He should gain as wide a knowledge as possible of the related sciences, specially chemistry, and seek to find the salient points of contact of the other sciences with physics.

3 He should be a man among men, touching men at many points, helping and uplifting, always a man whose life embodies that strict conformity to the laws of being which his chosen science so perfectly exemplifies.

Prof. George M. Turner—Prof. Thwing's remarks about the tact needed in experimenting in physics are very true. It is sometimes a difficult problem for a teacher to gracefully get out of an experimental trouble. It requires a quick eye and a cool head to take advantage of a failure to have things go as they ought to go, and turn all toward success.

I recall two instances of experimentation apropos of this point. Some time ago I visited an evening's entertainment in which the instructor of the college had divided the work of presentation of the subject among the young men. Each had his prescribed part and was expected to make his explanation and experimentation fit with that of the young man preceding. The explanations were well learned and related how the experiment would work and what consequences would follow certain conditions. Unfortunately in many cases the experiments would not work and the consequences did not follow the young men's conditions. Very naturally the young men became decidedly embarrassed and matters became very much confused. Probably the audience suffered as much as did the chagrined young men.

Another time at a lecture the unexpected happened, but the tact of the experimenter turned failure into success. The Chinese ambassador had come over from Washington to visit the Johns Hopkins University. At this time Prof. Remsen was lecturing to his classes on hydrogen. By one of those unfortunate coincidences, the oxygen and hydrogen had mixed in the wrong place and a terrific explosion followed, wrecking much of the apparatus on the table.

The Chinese ambassador, thinking this part of the program, loudly applauded, while Prof. Remsen coolly bowed his acknowledgments of the appreciation, said "Thank you," and went on with his lecture as though nothing unusual had happened.

Prof. W. M. Booth—I would like to ask Prof. Thwing what he considers the minimum training in mathematics and physics for a properly prepared physics teacher.

Prof. Charles B. Thwing—He should get all the training he can get. I would not specialize in mathematics and physics to the neglect of the other sciences. Elementary mathematics he ought to take, then trigonometry. I do not know that he needs calculus with his other training. It ought to be possible to experiment in the language the student understands already.

The idea I had was, that every teacher should have had a full course in mathematics to do satisfactory work in a high school. Possibly some succeed without it, but some do not.

Inspector Charles N. Cobb—I was reminded during the delivery of this paper of a little incident which happened last summer. One sunny, sultry, Sunday afternoon, there came up to my front porch in Albany a gentleman of my acquaintance who came on some church business. He brought with him his son, a young man who had completed a year's postgraduate work in chemistry. After the excuse for the call had been cared for, he spoke of the fact that his son thought of teaching chemistry, and that he thought, also, of becoming a professional chemist. His father was so situated that he could go on with his work for several years without providing any income, and the young man said he thought he would like to teach chemistry, but he thought possibly it might become monotonous. He thought he might have to teach the same thing year after year and it would be monotonous. I suggested to him that he might be teaching the same thing year after year, but that he would not be teaching it to the same persons; that, however, if his object in teaching chemistry was not to inculcate into his subjects as much as possible, but was simply to teach it, the probabilities were that it would become monotonous. On the contrary, if his object was to make men and women and to do it by teaching chemistry, it would not be monotonous at all.

I was glad that the reader of this paper referred to this same idea. I believe most heartily, that we should constantly remem-

ber that the object in view in teaching is to make students who shall have the ability to think and to do.

This morning, I think it was, that reference was made to that little book of Prof. James (*Talks to Teachers*), in which he remarked that, "the best educated man is he that can do the most useful things with the least effort." I think we will all agree that the *subject* of physics will go as far to assist students to do useful things as any subject that is found in the curriculum. And I believe the *teaching* of physics will go farther. When I say to do things, I mean to do them not only with the hands, but the brain as well.

Again, if you will allow me to refer to my observations. As I go about the state I find not a few who are striving to teach physics who are not able to do things with their hands, teachers of physics who can not manipulate apparatus.

Some of you were present at the address of Prof. Nichols at the Ithaca meeting, and you remember that one of the things that he did that evening was to produce different types of vibrations of a cord. He remarked that the experiment was a success, but he also remarked afterward that he did not do as well the first time he tried it. The habit of manipulating on the part of the teacher is an important matter.

I believe that the teachers of physics are as well prepared as the teachers of many other subjects, but we have every reason to desire marked improvements.

Prof. Howard Lyon—There is one feature of the paper read today that was specially interesting to me—that in which the speaker called attention to the difficulty in learning physics, due to the abruptness of the subject-matter. It is to me one of the most important considerations to the teacher of physics and deserves a more extended reference than was given to it in the paper.

I wonder why the secondary schools do not adopt what is excellent in the methods of the colleges. These methods are not ideal but certainly in one respect they are right. The college plan does take into consideration the time element in its instruction.

An individual can not take his three meals in the morning but he must have an opportunity to repeat his meals as he can digest and assimilate them. Facts and principles in physics require time for mental digestion and assimilation.

I do not advocate a sweeping reform in our methods, but I do know that lessons in physics and science in general can not be crowded to advantage. We try to teach physics in 20 or 40 weeks, and its new matter comes too abruptly to permit even superficial understanding in most cases. This fact is specially true in the case of girls whose early experience with reference to physical facts and phenomena is limited.

Expert opinion seems to differ as to the nature of the masculine and feminine mind, but I am sure that the difficulties that girls meet in physics arise not from the difference in their nature mainly, but from the poverty of their fund of observational knowledge.

Girls are not permitted to see mechanical devices in their childhood, and mothers seem reluctant to encourage observation and interpretation of physical phenomena. If girls could have a better opportunity to observe in their early life they would be better prepared for their high school work. If their training is not begun in their homes it should be begun in the schoolroom.

Every girl that I have ever taught has been a splendid student of physics if she has been what is termed a "tomboy" and she has always taken up her advanced work with enthusiasm. I am now teaching a girl who runs, jumps and throws a stone as well as a boy and she is an excellent student of physics.

Much is said of nature study. This instruction has, in a large manner, omitted experiments that have to do with physical forces. The phenomena of the air, of lightning, wind and storm are not less attractive than the phenomena of life. Why can we not begin in the grammar school with lessons concerning physical forces, something that would lead a boy or girl to understand mechanical devices? Why not let them have occasional lessons and simple explanations of principles that are

now restricted to high school pupils? Why can not the teacher present these lessons very simply, not as formal science but as simple practical instruction? I have seen marked results in later development in the case of students who had had simple lessons in their early training in physical phenomena.

Prof. Charles F. Binns—I am very much interested in this discussion of the study of physics and particularly the turn which the discussion has taken. I think that it is very evident that the girls might take a different attitude toward the subject of physics. I believe that the feminine mind will continue to measure her dress by her fingers. It is something like the Irishman who said, "It is twice the breadth of the length of my hand, and the width is as thick as a brick."

As a means of measuring the capacity of the teacher, it is out of the question to ask, how far it is necessary to go to qualify in a certain subject. The more reserve force a man possesses may be the measure of his success as a teacher, but knowledge is not the only necessity for the aptitude to teach successfully.

It seems to me, that in this subject of physics the general aptitude for mechanics should come well to the front. The most successful teacher is the one that can handle tools.

Prof. H. J. Schmitz—I am somewhat troubled in my teaching of physics to know the amount of theory to use in connection with it. I think the less theory we take the better it is. I should like to know what other teachers do.

Prof. C. B. Thwing—We are teaching half a dozen sciences in one and the student must be helped to remember a great many facts. A theory, even though not proved to be true, may be a great help to the student in classifying the facts and remembering them.

To illustrate, I sometimes tell a little "fairy story" to explain latent heat. Where does the energy go to that is used to melt a body? If we think of the molecules as having different dimensions along different axes it is possible that when a definite temperature is reached the molecules begin to rotate about their longer axes. This would consume energy and increase

the freedom of motion of the molecules without raising the temperature. The side bonds would be neutralized, while the end bonds hold the molecules together in the liquid form. When all the molecules have been put in rotation the temperature would again rise, till at the boiling point the molecules begin to rotate about their shorter axes and cohesion is entirely destroyed, and the gaseous state is reached.

The student is helped by such concrete pictures to master the abstract laws of the science.

PREPARATION AND TRAINING OF THE TEACHER OF CHEMISTRY

BY DR LYMAN C. NEWELL, STATE NORMAL SCHOOL, LOWELL (MASS.)

A recent number of a popular educational journal contained the following significant statement, "One becomes weary of listening to the numerous descriptions of what the teacher ought to be, when teachers are and will continue to be just ordinary mortals." At a first glance this assertion seems true, but a more careful consideration leads us to conclude that it is a specious half truth. The programs of educational gatherings during the last five years in this country and in England have had one marked characteristic, viz, an unusually large number of papers and addresses on the art of teaching. This is specially true of those meetings devoted to science. At the meeting of the American Association for the Advancement of Science held at Denver in August 1901, seven papers on the teaching of chemistry were read before the Chemical section, one of them being the annual address of the vice-president and chairman of that section. These papers covered all branches of pedagogic chemistry, and their presentation confirms the view that, however weary some may be of hearing what a teacher and teaching should be, all are not disposed to ignore the public presentation of this means of improvement.

Believing this, I willingly accepted the invitation to present to you some thoughts on the preparation and training of the teacher of chemistry. Progress in teaching comes largely from consultation, comparison and publication. Bad methods can

never be eliminated by concealment, nor can good ones be spread by hiding them under a beaker or in a water bath. Methods need constant regeneration. Education, specially in science, is evolutionary. There are few long steps, few sudden leaps in our work. We must keep moving; the fountain must be constantly playing. Cessation is stagnation. I hope the time will never come when we can not talk, write, consult and argue about our work.

Teachers of chemistry need a broader, more uniform and more accurate knowledge of the fundamental facts and principles of chemistry. The foundation is essential to the stability of any superstructure. If our knowledge of the fundamentals is uneven, or out of plumb, then our superstructure will be rickety and in danger of cracking or of falling over at some critical moment. Several reasons lead me to emphasize this factor in considering the preparation and training of the teacher of chemistry.

At the last meeting of the Johns Hopkins University Alumni Association of New England a classmate, who is connected with a large college, said, "The weakest part of our course in chemistry is the general inorganic for beginners." This is true, no doubt, of many other colleges. Several unfavorable conditions attend the instruction of beginners in chemistry in college. The laboratory sections are often too large to permit individual instruction, the text is usually presented to indifferent listeners in the form of entertaining lectures or of an intricate outline, and the course itself is often condensed to ridiculous brevity in order to conform to the unavoidable restrictions of the curriculum. It is true that these conditions are sometimes unavoidable and that the department of chemistry is only partly responsible for them. Nevertheless, the students suffer, and too many graduate from college inadequately prepared to teach elementary chemistry, because their instruction in that portion of the subject has been irregular. It is as true of chemistry as of most subjects, that we know best what we studied last. And many a recent graduate attempts to force his latest work on

suffering and helpless beginners. Pres. Remsen once said, that when he left the University of Tübingen he could teach the most advanced organic chemistry better than the elementary inorganic chemistry. In many colleges the student passes directly from general chemistry to qualitative analysis, then to quantitative analysis, and finally to organic chemistry or some other advanced work. Seldom does he have a chance to review his general chemistry from a broad standpoint. There is a tendency in some institutions to remedy these defects, and before many years students while in college will be able to lay those broad foundations which are so essential for effective teaching of elementary chemistry.

A second reason for emphasizing the necessity of a better knowledge of the fundamentals is that in the last five years such an enormous number of facts have been literally hurled at us that those houses which are built on the sand are in danger of being swept away. Physical chemistry, electro-chemistry, chemical inactivity at low temperatures, dissociation at high temperatures, matter inert at all temperatures, radiant energy, molecules of eight atoms, molecules of a single atom, and liquefied gases galore have been suddenly thrust on us. I am not a foe to these newer conceptions, nor am I indifferent to the magnificent results obtained by such men as Ramsay, Nernst, J. J. Thomson, Van't Hoff and others. But important as these topics are and will become, they should not be allowed to usurp or obscure our conception of the foundations of chemistry. A teacher in one of our Boston high schools was asked by the writer what use he made of the theory of electrolytic dissociation. He replied, "I did considerable last year, but this year I shall do very little because my pupils did not see so much in it as their teacher did." Doubtless a similar vision of the situation led one of the best known teachers of chemistry in this country to say in the preface of his latest book, "In the opinion of the author the time has not yet come for the abandonment of the study of the elements and their compounds in what some are pleased to call the old-fashioned way. Indeed

it seems essential that such study must always form the basis of the higher or spiritual study of chemistry." In a few years, no doubt, many of the simpler aspects of physical chemistry will form a part of our elementary courses in chemistry and must therefore be assimilated by teachers, but since physical chemistry is now only a part of the superstructure, it should not be mistaken for the whole edifice. Only the teacher who has a broad knowledge of fundamentals can appreciate the meaning of new details, for such a one alone can determine the value of component parts of the whole. Comfortable teaching is based on an accurate knowledge of the first principles, it rests on unshaken confidence in the primary truths. The teacher who lays the foundations wide and deep need never fear overthrow. On them he can build with assurance as high and attractive a superstructure as desired. A teacher runs no risk of being left behind in taking a year or more to strengthen the foundations. He can easily catch up with the facts, and as he moves onward these facts will find a logical and permanent location in his mind.

A convenient and efficient way to obtain a knowledge of the underlying facts and principles of chemistry is by a judicious and thoughtful study of one of the large manuals of chemistry, such as Remsen's, Mendelieff's, or Freer's, Newth's, Richter's, or Roscoe and Schorlemmer's. Working familiarity with any of these books is an enviable acquisition. They are reservoirs from which we may draw our supply at any time. Make a business of it. Take a year for the task, if necessary. Read with a notebook at hand, or better still mark the margin of the book itself. Determine to remember where and how the facts and principles are treated. Imbibe the spirit of the author, see the truth from his standpoint. Do not be satisfied till the task becomes a pleasure. Gradually the whole panorama will come into view, facts hitherto unknown will assume their proper relation to the whole subject, experiments which one may have thought were his own discoveries will be accredited to the rightful discoverer (possibly Boyle or Lavoisier), laws will reduce themselves to

that beautiful simplicity which is an expression of an harmonious nature, theories instead of being mere guesses will inspire to deeper thought and perhaps to intelligent experiment, and out of the vast mass of facts, laws, hypotheses, and theories a foundation will unconsciously be laid on which can be built with confidence and skill a superstructure in which ideas new and old may be harmoniously, artistically, and truthfully incorporated.

The preparation and training of the teacher of chemistry should not be confined solely to this science. Interest should be stimulated in allied sciences. No single science is an independent unit; all overlap. Chemistry has some connection with all the physical and life sciences. Together with physics and pure mathematics it forms the great triangular foundation of physical science. Hence a general knowledge of other sciences is not only helpful but to a certain degree necessary to the successful teaching of chemistry. Such a knowledge keeps one from becoming warped and prejudiced in his judgment of the methods, value and significance of other subjects in the curriculum. Love and enthusiasm for chemistry should not mean contempt and hatred for physics or biology. In answer to the question, "Do you prefer to teach another science besides chemistry?" 19 out of 20 representative teachers in Massachusetts replied "Yes". Those who taught physics invariably regarded this additional work as helpful. The speaker has found physics and mineralogy exceedingly helpful in interpreting many phases of general inorganic chemistry. A science needs a margin, a sinking fund, a reservoir, just as a picture needs atmosphere or a poem needs inspiration. A knowledge of perspective alone will not make an artist, nor will a knowledge of prosody make a poet. And it is just as true that a knowledge of chemistry alone will not make a good teacher of that science. We need "the more" to apply "the little", something beyond the subject to teach subject-matter. Our point of view, our estimation of values, our humor, our judgment, our mental horizon, our general reading, and our hints for the pupil's reading, all these really depend on something outside of mere chemistry. Photography, astronomy,

mineralogy, geology, and physical geography stimulate interest in certain aspects of chemistry. This margin, this finish, this better part is that indefinable something which places the inspiring teacher on the right hand and the dull pedagogue on the left.

Probably most teachers of chemistry have at one time or another studied other sciences. It is advisable to arouse this dormant interest and to acquire a generous sympathy, a working knowledge of these sciences. This may be done by reading the scientific journals, such as *Science*, *Scientific American*, *Popular Science Monthly*, *American Journal of Science*, *Journal of the Franklin Institute*, and by all means the latest journal, *School Science*. Avoid newspaper science. It is usually downright absurdity or barefaced error. A few hours judicious reading during a month will suffice to keep pace with all that one need know of other sciences. Form the habit of reading these journals and stick to it. A German professor was once asked about the progress of a former student. He shook his head and replied, "*Ach, er liest nicht mehr*" (alas he reads no more). Let us take care that we are not similarly condemned.

A few years ago the New England Association of Chemistry Teachers sent out a list of questions, mainly to New England teachers, covering all phases of teaching. Among the questions was this one, "What is your aim as a teacher of chemistry?" An answer which typifies the aim of the best teachers was, "To teach pupils a love for truth and for the science, and to develop a scientific spirit." A most desirable requisite which teachers themselves need is a scientific spirit, or, perhaps better, a scientific attitude of mind. The distinguishing feature of science teaching is not merely the provision of an opportunity to observe, conclude and record. Its vital object is to create and foster a scientific attitude of mind. The highest attainable result will follow, if a scientific spirit is aroused.

That attitude of mind called scientific is hard to describe. One of the most scientific teachers of chemistry in the United States said, "It is asking a great many questions, but few foolish ones." Some of its attributes are a determination to know all

the evidence before pronouncing a judgment, precision in thought and statement, a desire to deal with the thing itself, not trusting to secondary sources, unshaken confidence in the triumph of truth, fearless abiding by tested results, willingness to change our conclusions when new evidence is presented, disbelief in the traditional superstitions and nonsense of our ancestors.

Sometimes contrast makes a subject clearer, and possibly the term scientific may be made clearer by illustrating an unscientific state of mind. To deny the truth of what displeases us is unscientific. We have had an excellent example of this species of unscientific behavior in the naval battle recently fought on dry land and in the newspapers. It is also unscientific not to admit our errors, specially our published errors. It is likewise unscientific to accept elastic theories. Prout's hypothesis, the evolution of the elements from a single element, and theories which violate the laws of thermodynamics belong to this class. It is furthermore unscientific to jump at conclusions which we would like very much to draw, if we only had sufficient evidence. How many new elements are annually announced! How many new discoveries are daily heralded which will set the earth spinning from the east to the west as soon as the pseudo-discoverer has obtained a little more evidence! We need more chemists like Morley and no more physicists like Tesla, we need more astronomers like the late lamented Kepler and no more like—well, I must not be captious. I am sure the point is clear.

Probably no general rule can be prescribed for the attainment of a scientific attitude of mind. Yet it can be cultivated. One of the best ways to acquire and foster it is to do some original work. It matters not how extensive or how slight the work, provided it possess the element of originality. Nature by some inscrutable law has decreed that we can learn only of and through ourselves, no one else can learn for us. The soul itself must come to a consciousness of the truth before knowledge is a possession. Every bit of original work coins knowledge. An original demonstration of the hitherto unknown properties of a

chemical compound is worth more to the experimenter than a vast mass of memorized facts. The construction of a new piece of apparatus or the improvement of a method demands continuous exactness of thought infinitely more helpful in acquiring a scientific attitude of mind than can be gained by the remodeling of a whole scheme of qualitative analysis. One reason, I fear, why some teachers shrink from the performance of a few simple experiments demanding exact weighing or measuring is their inability—or would I not better say unwillingness—to carry out the train of reasoning involved in such work. A few hours a week—part of our wasted time—spent in the performance of some original work will soon give that attitude toward teaching science which a genuine judge has in the trial of cases. It will give a mental grasp which is comprehensive enough to perceive the exact value of evidence. It will bring one face to face with truth.

It is impossible, however, for all teachers of chemistry in secondary schools to do research work. Numerous duties consume all spare time, apparatus and materials are not readily obtainable, and books and chemical literature are not always available. On the other hand, it is possible for such teachers to do some work possessing the element of originality. The simplification of apparatus, the wider application of new methods, the qualitative examination of some mineral, rock, mineral water, or industrial by-product offer ample opportunity for original work. Again, if no such work can be done, the teacher should write. Exactness of statement is a mark of exactness of thought. And exactness of thought may be acquired by critical writing. Put your thoughts into accurate language. Tell us about some interesting natural phenomenon in your locality, an example of chemical erosion, a piece of apparatus which has helped you over a hard place, write a brief biography of some of the newer chemists, tell us about anything which interests you. What interests you will surely interest someone else. A managing editor of *The Sun* (New York) when asked by a correspondent what to write up, replied, " Anything

that interests you—nothing else." Stevenson always carried two books in his pocket, "one to read in and one to write in." Publish what you write, read it before some association or to a friend. Help overcome the false notion that a scientist can not write clearly and entertainingly. Help make it impossible or at least untruthful for an editor to announce in a prospectus, "We assure you that these articles on science will be both good writing and good science, a combination that is unfortunately too often lacking."

Till about a decade ago chemistry was taught in high schools almost exclusively by a textbook. The pupil studied the book, recited what he had time to memorize, and occasionally listened to lectures or talks by teachers who often did some experiments. This unscientific method of teaching the science of chemistry began to be abandoned about 10 years ago. Some schools went to the other extreme in allowing the pupils to do all the experiments, while the teacher did the studying and reciting. Fortunately the evil effects of this second unscientific method of teaching the science of chemistry were soon discovered, and it is gradually being replaced by a judicious combination of individual experimental work done by the pupil, study, explanation, and recitation of textbook by the pupil, and largely informal lecture instruction by the teacher. It would be profitable to discuss the bearing of these three elements on the preparation and training of the teacher of chemistry, but the time at my disposal compels the limitation of the discussion to one phase of one element, viz, the supervision of laboratory work.

It seldom happens that a method of teaching changes suddenly, but when the change is abrupt, the application of the new method is attended with more or less misfortune. The laboratory method of teaching chemistry came on us rather suddenly, and in many schools its use has not only been injudicious but unprofitable. We know very little about its psychology and still less about its ethics. Many teachers can not account for their failures, and hence they are not slow to condemn the laboratory method, whereas it is the fault of the teacher, not of the

method. Though my views on this question have appeared in print, I can not refrain from repeating some of them, because I believe the failure to grasp certain psychologic principles accounts for much of the aimless work done by pupils and for some of the unrest, discomfort, and inefficiency shown by many teachers in all sections of the country.

Laboratory work is concrete labor. It employs the hands as well as the head. Concrete labor is difficult to shirk. In studying history, geometry, or language the mind easily wanders. But when the mind is following an experiment in the laboratory, it does not readily ramble. Something is constantly happening; the mind being carried quickly from concrete to concrete has little or no time to roam. Apparatus must be arranged, chemicals collected, the experiments started, watched, controlled, or stopped. If, however, the teacher or the principal does not favor laboratory work, if the program restricts the experimental work to a pitiable minimum, if the teacher persists in explaining in the classroom what the pupil can think out unaided in the laboratory from his own data, then it is folly to expect the laboratory work to yield mental results. There must be enough carefully prepared and judiciously supervised laboratory work to prevent the normal tendency to shirk and to teach the pupil the supreme value of mental self-reliance. Again the experimental work must be dignified enough to command the self-respect of a thoughtful pupil but not so difficult or repulsive as to frighten him, for in either case the tendency to shirk will be hard to overcome. Furthermore, the laboratory work must be followed up by searching questions, for if the pupil once gets the idea that he need not think after he has completed his experiment, then you have opened for him a broad avenue for shirking. Each pupil should be taught at the earliest possible moment that he or she may be asked any reasonable question on any experiment. If such a spirit prevails, pupils soon learn to get from this concrete labor that invaluable acquisition, so often needed in later life, viz, the power to complete a piece of work accurately, quietly, quickly.

Again laboratory work is suited to relieve mental fatigue. It is restful work, if rightfully performed, because it affords opportunities for harmonious activity. But, if the laboratory

period is too long or too short, if confusion reigns, if there is no opportunity for pupils, specially girls, to sit down in the laboratory while writing notes, consulting reference books, or performing slow experiments, if the directions for performing the experiments are brief, long, or so vague that their interpretation demands an excessive amount of mental energy, then mental fatigue will be increased, not relieved. The laboratory work under such circumstances can not afford that mental rest which it is designed to provide. Mind and body will refuse to act normally.

Third, laboratory work is a grand medium for the production of the highest grade of reactive conduct. Reception is followed by reaction, impression by expression. Motor activities are the expression of thought. But, if the laboratory work is inadequately supervised, owing to large divisions, program irregularities, or pedagogic inefficiency, then the reactive conduct will be of a low, perhaps the lowest, grade. The pupil who is called on to be doing something constantly should be stimulated by an environment which will enable him to do the right thing in the best way. Good expression can not come from bad or meager impression. Teachers of chemistry who let the laboratory run itself, who do not help a confused pupil to regain mental poise, who do not realize that beginners need constant advice and direction, are unprofitable servants of the science of chemistry. The teacher's place is beside the pupil, showing him how to form good habits of observation, teaching him the difference between accuracy and vagueness, preventing him from doing slipshod or slovenly work, stimulating him to cultivate mental self-reliance, not telling him facts which he can observe himself, but suggesting legitimate channels for the application of his total power. I recall with pleasure my work under Pres. Remsen, because he never discouraged me when I needed help and he always left me to myself when he saw that the best avenue of escape was through my own mental efforts.

Again, we must not be satisfied because our pupils are curious. Curiosity is a good sign, but at best it is only a means to an end. It should be encouraged at first, but, once active, it should be rationalized. Pupils must be led from curiosity to interest, from mere indiscriminate desire to know disconnected

facts to an intelligent craving for systematic knowledge. The transition from curiosity to interest is a critical time for both teacher and pupil. Too often a thoughtless word, an unintentional oversight, or a palpable lack of interest on the teacher's part may upset the delicate poise of the pupil's mind and turn to permanent indifference or reckless curiosity what might have become lifelong interest. Special care should be taken by the teacher to gather up the disconnected observations made by pupils and place them before the learner in such a light that the threads of curiosity will become the fabric of interest. Once interested, the pupil should be led on into the realm of voluntary attention. It is this factor that we all need to develop, for it is of incalculable value in the acquisition of knowledge; it is essential to complete psychic life.

Pupils seldom see the importance of voluntary attention. They are contented to "do experiments" and stop there. They need to be taught the fundamental value of learning to complete with success an experiment requiring patience, skill and confidence. The necessity of teaching voluntary attention is one reason why I believe so firmly that simple quantitative experiments should form a definite part of an elementary course in chemistry. Such work cultivates voluntary attention. As I have watched my classes for several years perform simple experiments involving accurate weighing or measuring, I have been forced to conclude that this work is the most effective way of teaching voluntary attention. It requires an effort of the will for spirited pupils to sit quietly before a balance till the pans stop swinging, to wait for a solution to run down the inside of a burette before the volume is read, to let a thermometer remain in a liquid long enough to assume the temperature of the liquid. But this very effort of the will is needed day after day when the pupil leaves school. It must be acquired, if one is to be a successful worker in any field.

Whatever or wherever our occupation, whether in Syracuse or Manila, we shall always need the power to think continuously, work skilfully, and judge accurately. We do not need chemists half so much as we need men who will voluntarily attend to their work. The problems which are coming on us as a nation need for their solution men who have been trained

to do things accurately, with dispatch, with a regard for all the evidence, with a profound love of truth, for that truth which is so forcefully exhibited by the laws of chemistry, for that outer truth which arouses in one a consciousness of inward truth.

Closely related to curiosity, interest, and attention is the principle of inhibition. It was thought about half a century ago that certain nerves checked the action of certain muscles. This is doubtless true, but it is a narrow interpretation of a more general function of the nervous system. This conception of arrest has been extended to cover our mental life, irrespective of nerve stimulus as such, and is called inhibition. It is not necessary that an inhibiting idea be specially strong to arrest another idea, for here as elsewhere the mental machinery is delicately adjusted. A strong motor idea may be easily and completely inhibited by a simple and apparently foreign idea. Faint impressions on the confines of consciousness may throw a strong idea completely off the track. Some trivial observation may upset a thought which is seeking expression, and either arrest it completely or so modify it that the final judgment is delayed or even completely abandoned. Pupils should not be allowed to yield to unwarranted inhibitions. Provision should be made in all laboratory work for allowing the pupil's mind to travel without needless inhibitions from the object of the experiment through the manipulation to the conclusion. The work should be so supervised that pupils will see the whole field of consciousness and not yield to reckless impulse or foolish inhibition. Many books now in use actually prevent the mind from acting calmly, continuously, and logically. Experiments to be mentally profitable should be so expressed and arranged that the average pupil can not fail to grasp the title, the exact method of procedure, the essential observations to be made, and the probable conclusion which the observations will permit. The title of each experiment should be known so that the pupil may have an initial idea, a mental start, a guiding star. Unless he begins correctly, he may not, probably will not, end correctly. A knowledge of the exact method of procedure is essential, otherwise he will not know how, when or where to begin his work, nor can he carry it on intelligently, confidently, profitably. A great deal of time is wasted in a laboratory because pupils do

not know how to work, and in many cases they are not to blame for this aimless, fruitless labor, because they were not at some time told or shown how to work. They yield to some foolish inhibition or reckless impulse, simply because they see no other path. Again, the desired observations should be indicated in some way. Pupils are learning how to observe; one object of experimental work is to teach observation. Surely we ought not to assume what we are trying to teach. Beginners do not know the difference between the trivial and the important, the scientific and the unscientific. They must be pointed toward the path having the fewest inhibitions, even though such direction reveals some truth which they might possibly discover if sufficient time were taken. Finally, each experiment should lead to some definite result. Otherwise the student is left suspended, is actually robbed of the inestimable privilege of drawing a conclusion. Experience shows, however, that this conclusion must be indicated. It need not be deliberately told, but it can be suggested by appropriate questions. Such questions eliminate inhibitions, they conduct the mind along a logical path, they extend a helping hand to a halting thought, they train the mind to pass from cause to effect.

If you ask how the teacher may attain the power to apply these principles, the answer is simple. Study your pupils and yourself, but yourself the more. The problem has only two unknown quantities—yourself and your pupil. Success depends on the teacher's knowledge of his own psychologic and spiritual life as well as on the discovery of mental crises in his pupils. He must create an atmosphere which fosters calm, deliberate, confident, tranquil mental action. He himself must have passed through the gates of curiosity and interest into the temple of voluntary attention before he can lead others to the same spot. He must acquire that spiritual insight which perceives the truth in himself, he must be constantly conscious of that better self, for it is this unseen self which teaches.

Section B. BIOLOGY

PREPARATION OF SECONDARY TEACHERS IN BIOLOGY

BY PROF. FRANCIS E. LLOYD, TEACHERS COLLEGE, NEW YORK

We may well, at the outset, present our conception of the high school as a factor in the preparation of men and women for their life. The most important feature of the high school lies in the fact that it is the final and only school of higher education for the multitude of men and women in the higher walks of life. Only a very small proportion have had or will have in the future more than a high school training. To give the very best opportunities for that education in the most efficient way is a task worthy of the best efforts of highly educated, trained and earnest teachers, which our unexampled opportunities for higher education can supply. This much must be conceded and kept ever in the foreground of the teacher's consciousness that to do the daily round of duties as a leader of a generation of youth just on the threshold of manhood and womanhood is a high privilege not to be measured by dollars and cents, nor even by the approval, often too tardy, of the audience of parents and supervisors, but by the conviction that his work will surely count for the amelioration of the individual morally, mentally and physically. A teacher with such a conviction, and thoroughly equipped for his work is filling a high office in society. It is not too much to expect and demand that persons who look to filling such an office shall be able to satisfy all the demands for efficiency which may in justice be made on them.

What, then, are the demands as actually formulated? On this point there is at this time no general unity, but for our present purpose we may examine the regulations formulated by New York city. These represent the maximum demand, and will serve for the time being as a goal for which the rest of the country would do well to strive.

Scholastic attainments and teaching experience are set off against each other. When the former are present, in the highest amount, they consist in bachelor's degree and two years' postgraduate study, accompanied by some knowledge of the science of education. In the absence of these, eight years' successful experience may be substituted for them. Though these

demands represent the extreme in this country, it will be noticed that a candidate may enter the work with no teaching experience and after no special study of the problems which he has to face, and the special methods of the subject involved. Otherwise, the demands are fair, and have been effective in building up a body of efficient teachers.

Let us now turn our attention to the actual conditions which obtain in the large majority of our high schools throughout the country. The teachers may, roughly speaking, be considered, as to their origin, as consisting of two groups; those, namely, who have had no regular opportunities beyond the normal school and whose preparation has been received primarily there; and, secondly, those who are college graduates merely, or hold one or more of the higher degrees. It must not be understood that we are, in considering these facts, launching any criticisms against the many able teachers who, with acknowledged incompleteness of training, are themselves doing all in their power to advance the educational work of the high schools. It is, however, necessary to collate the facts in order to aid in bringing about the much needed development toward a uniformly high standard of work. The greatest step toward this is gained when we demand and get uniformity in the preparation of the teachers themselves. And by uniformity we mean, not a rigid formal kind of uniformity, but a uniformly high grade of teachers, whose work shall always be above a standard of quality we can hardly at present be said to have reached.

The teaching force of our high school, then, is made up, in the first place, of persons who have at best made use of the opportunities afforded by the average normal schools. Of such, some have gone directly into high schools after, perhaps, supplementing their attainments by taking courses in summer schools, at seaside laboratories and the like. These persons have had, it is admitted, certain advantages over the college-trained, to be considered later, in that some attention has been paid to the general and particular educational requirements demanded of the candidate for school positions. We must observe, however, that such training as they get is very insufficient in amount and admittedly adapted, not to the needs of the secondary, but to those of the elementary teacher. And here we contend that

preparation for elementary teaching is not preparation for secondary teaching any more than experience in the university prepares for efficient work in secondary instruction. It may be and has often been maintained that it involves merely a question of adaptability on the part of the teacher. Without denying the contention, we still hold without fear of denial that the facts observed indicate pretty strongly that such adaptability is lacking, and the practical result is that we find at the present moment all kinds of courses, from essentially college work to essentially grade work, offered to the high school student. And this is not right.

It very frequently happens also that teachers in the elementary school, allured by the large money return to be obtained in high school positions, amplify their normal school training by taking work in the summer and seek high school places. This indicates an ambition on the part of such teachers which is at once to be commended and deplored, and a condition in our school system only to be deplored. We condemn without qualification the failure to recognize, in an economic way, the worth of the kindergarten and the elementary teacher. Their office is no higher and no lower, their responsibility no greater and no less than that of other teachers; and, utopian or not, we look for a time when the pecuniary reason for a progress, if we may so call it, from the elementary to the high school will be removed.

There is, however, another reason for the change sought by many teachers, a reason which must be recognized as valid and working out for good on the whole. Without qualifying our contention as to the equal value of elementary and higher education, we are forced to admit differences in temperament and mental life which make elementary teaching as much of a drag to some as a delight to others. These are differences which qualify or disqualify, and a man or woman whose intellectual life is not, to a fair measure, satisfied and stimulated by the more heterogeneous elementary course, may well endeavor to find satisfaction in the less heterogeneous character of the high school course. Recruits to the force of secondary teachers of this kind should be welcomed, but only on the satisfaction of rigid demands to be outlined further along. Barring such

exceptions as just indicated, we can not admit that the average elementary teacher who has gained admittance to the high school in the way here under discussion, is in any degree fitted for the work. Years in the lower school have fixed ideals and conceptions of teaching which, as expressed in method, are not adequate for the high school, and on the whole tend to lower the standard and nature of secondary education. Add to this the usually wofully deficient and hazy knowledge of the special subjects on which they are required to concentrate, and we have the cause for a lamentable degree of failure in development of the high school. If any proof is needed of the truth of the last statement, one has but to be subjected to the necessity of examining a few normal school graduates on the most important general knowledge of physiology, by which we mean physiology of animals and plants—knowledge which is fundamental for each and every teacher, without which any presentation of botany or zoology must necessarily be completely inadequate and misleading—to be convinced. I do not attempt to throw blame on anyone, teacher or student, in particular. The normal school has avowedly its definite object in preparing teachers for elementary work. It certainly can not, under its present construction, expect to do more. It is maintained that the means to one end may not properly be regarded as the means to another.

Before closing this part of the subject, it would be only fair, if time permitted, to consider at greater length the case of teachers who, after extending their education by studying at summer schools, gain entrance to high school teaching. To make sweeping generalizations is here specially dangerous, and the best one can do is to argue from the few definite cases which come under one's notice, and from the nature of the preparation in general.

In the second place, we see the high school staff recruited from the ranks of those who have received their bachelor's degree. This implies at most some general work in education proper, without any practical work, and at best an insufficient knowledge of the subjects which the candidate is required to teach.

It will be seen that the normal school graduate is thus in a position of advantage in point of professional training, and on

this rests the belief, only partially justified, that the deficiency in scholarship is made good. We may here not improperly acknowledge the debt the community owes to the normal school for carrying on a work which has made for a body of teachers of constantly increasing efficiency; we still maintain, however, that the aim of the normal school is at a different—not a lower or a higher—mark than that of the high school, and therefore is inadequate to our present needs in this regard.

That the college graduate is not sufficiently prepared for the work before him as a high school teacher may not be doubted. His attainment is represented, in biology, by, say, two years of zoology—occasionally more, often less; and what shall we say of botany? In a great many cases, the credit of a 14 week course in "analysis" or "picking flowers to pieces" is a flattering maximum. Very frequently, in many of our leading colleges, a sort of appendage to the course in elementary biology, by a zoologist, is made to do duty for the whole subject of botany. It would be laughable if it were not almost pathetic. Is it any wonder that elementary teachers in botany are still floundering around in a mire of antiquated morphology? Is it any wonder that botany, which in most people's minds is still "picking flowers to pieces," is regarded as a study for girls? An examination of a class of girls offering a college entrance option in botany had disabused the speaker's mind of even this. And it was Huxley, that veteran in the fight for progress in education, that urged so often the placing of botany and human physiology in the schools. Does any one suppose that, in his mind, botany was the namby-pamby kind of thing it has grown in this country so frequently to be?

The knowledge of physiology, too, which the college graduate, as such, possesses is very often far from sufficient to give him anything like what is called a grasp of the subject, and may more rightly be characterized as a conglomeration of confused ideas.

Here, again, I must not be interpreted as criticizing directly our colleges or their graduates, though neither may be said to be beyond criticism. Each institution has to be governed according to its own resources and can not, if it would, always satisfy external demands. Too often, however, they will not.

As to the students, they are ill prepared partly because of the failure, for one reason or another, to use all the opportunities at their command, or because of their immaturity. The latter, I believe to be the real difficulty. The college course in the matter of time alone does not mean enough in the effect it has in refining the judgment; and the acquaintance with the subjects has not been long and intimate enough to result in that accumulation of knowledge from direct observation which alone makes a resourceful and inspiring teacher, independent of the textbook and full of his own invention.

As to the particular knowledge of the practical problems in facing a class, in planning and carrying out a laboratory course adapted to high school students, we may say that they know nothing. The result has almost invariably been that teachers who have had no training in these lines have taken their college courses and given them in rarefied, if not clarified, form to their students, and there has been a misfit all along the line.

In those communities in which higher demands have been made, where, accordingly, teachers holding the master's and even the doctor's degree have been obtained, some of these insufficiencies have been less apparent, sometimes more so. For greater special knowledge of the subject, with the total absence of professional training, has not always been an improvement on the other condition. Eminently successful teachers who have never had a special professional training, there are, but in spite and not by virtue of their lack. To say that teachers are born and not made does not exclude the proposition that, granting the qualities of birth, they may be vastly improved by definite training.

Having surveyed the present conditions of education, we may now move forward to our conclusion by outlining the ground which, we believe, the training of the secondary teacher ought to cover.

The requirements may be regarded, for convenience, as those in subject-matter and in education.

[1]The requirements in subject-matter should consist in at least nine points of undergraduate study in biology, of which at least

[1]The following is a digest of the speaker's remarks under this head.

three should be either botany or zoology. The work in biology should be buttressed by thorough work in physics and chemistry.

During the senior year in college courses in education should be had, consisting in the history and principles of education, and in the theory and practice of secondary teaching in biology. The latter, with which we are specially concerned here, should consist in lectures treating of the various problems which confront the secondary teacher, of reading and discussion. This should, as far as possible, be made to yield practical results in giving the student exercise in the command of his powers of presentation. When possible, there should, also, be some time given to observation of public school work, carried on in an efficient and organized way.

The postgraduate preparation should consist of further study of biology at a recognized university for at least one year, during which period the student should receive training in methods of independent thought and investigation. This is not a demand that all secondary teachers should be actual research workers, but rather that the spirit and methods of the discoverer should be familiar to them through experience. At least the master's degree should be earned.

In education the work should consist in (1) a course in general secondary teaching, and (2) an advanced course in the theory and practice of secondary teaching in biology. The ground covered in such a course should be mainly practical, and should consist in a detailed study of the materials and methods involved, the construction of the course of study, and of actual teaching in the high school, under criticism.

The student's power to collate and organize the materials and to present the same in a scholarly manner should be evidenced by the preparation of a satisfactory thesis treating of some problem of secondary education. Such a course should lead up to the grant of a master's diploma coordinate with the master's degree, and of equal value with it, but with special significance.

The standard of scholarship set in the above statement is the master's degree, and, for the country at large, it is as high a standard as may at present be urged. It will be sufficient probably for some years to come, except in the largest cities, pro-

vided the scholastic attainments are accompanied by the equally important educational preparation.

Inspector Arthur G. Clement—I would like to ask Prof. Lloyd if the training he mentions presupposes a college education?

Prof. Lloyd—The first course is open to seniors, who have attained an average college record both in botany and zoology. We have allowed a student to take botany for the first time with the course. From now on, however, we have two courses, one of which will be open to seniors, and we can thereby allow them to take for the first one, either botany or zoology, whichever can be consistently taken with their course, but only in cases where it is absolutely necessary. In order to enter the more advanced course, they must have had at least two years' training in zoology and two years' training in botany, and at the same time must be pursuing original work in research.

Inspector Clement—A student should have a full course, and after that take up as much special work as he has time for. In addition to the training the teachers receive, they should have genuine love for the subject-matter and patience with the students. Teachers often fail because they have no patience. The student is not able to follow, and the teacher will not go over the work again. Hence I think that a good training should tend to make a teacher patient in helping dull students.

Prof. Henry R. Linville—The thought occurs to me that young people who are preparing for the profession of teaching, when not endowed with the necessary capacity for such work, should be made aware of their deficiency by training school teachers.

Prof. F. E. Lloyd—Of course a full college education is required, and preliminary knowledge of physics and chemistry is demanded. As to the points mentioned, love of subject-matter and patience with children, all those points have been taken up. As for me, I would not for a moment hesitate to criticize a candidate if I thought the motive was other than devotion to the profession, which should be the basal motive. As to the use of scientific literature, that is one of the things insisted on.

Prof. F. M. McMurry—I know a teacher who for years in the past has been obliged to work out his own experience. It has been somewhat to his advantage. By his experience he has

been able to learn more and to study his pupils more. They are specially trying to train teachers, so that it will not be necessary for them to practise on the pupils that are placed in their charge.

WHAT THE TEACHER OF BOTANY IN SECONDARY SCHOOLS SHOULD BE PREPARED TO DO

BY DR A. J. GROUT, BROOKLYN BOYS HIGH SCHOOL

[*Abstract*]

I came here with several things in mind which I wished to say. A great many of them have been said much better than I could say them. Consequently I shall be obliged to slight some things that I intended to emphasize.

Of course a great many people who begin to teach, teach things because they must be taught. I have come more and more to a conclusion which is very trite and accepted by everybody, in my opinion, but is not lived up to, that is, that the aim of teaching is to make better, nobler, and more capable men and women, and not simply encyclopedias of learning.

I am outlining what I would like to do. We have our ideals, but can live up to them only as circumstances permit. We are not able to live up to them because of personal limitations also. I am able to a great extent to live up to my belief with respect to drawing. When a youth begins the drawing of scientific objects, help to bring out the finest points. If you keep at him, he will see every curve in the line, and he certainly is trained in the habit of observation. Fidelity to truth is not so common as one could wish, nor sufficiently appreciated. In science we should have exact truth. If our boys must tell the truth in matters of science, the effects are seen in moral character, and in time will spread to the other departments of life. Botanical knowledge offers general popular instruction. It should give to every one a new interest in life, an interest that can be taken up when other things fail. You see the lady in the city playing bridge whist, and the farmer's wife in the country lowering her moral nature, and injuring herself with gossip. A study of botany may correct these things and give new inspiration to those who otherwise have little hope in life.

I think a teacher who is training boys and girls and can not find and give the name of a flower is at fault. Finding the names of plants was formerly the basis of botanical work; and in cases where the study is properly taken up and properly adjusted, I know nothing more helpful in many ways. In my personal experience I have found it invaluable. I want pupils to ask themselves questions; if they find anything interesting in nature, to know what it is. What would our friends be to us if they were nameless? So in plant life. A person reads the description of a common and interesting plant; he can not connect it with the plant he knows unless he has a knowledge of names. I have never failed to awaken enthusiasm when I gave my pupils a proper knowledge of this part of the work. I give them the key if possible, and I want them to be able to find the names of a few flowers in the key. Prof. Ganong has said that this kind of work should be done as outside work by pupils who have special enthusiasm. I think there is a much more general need of this kind of botanical work than this. I would insist that all high school teachers should have the ability to name common objects.

The chief thing in the training of a teacher to do good work, is a love of the subject-matter and a love for the pupil. Enthusiasm is necessary to do anything well. What receipt do you give for enthusiasm? If you want to get it go where it is. It is communicated by contact. You want to go to those institutions where teachers are enthusiastic; and right here I want to add a protest against that great and influential university which discourages enthusiasm. If you want enthusiasm in botany, I can tell you places where it is, Columbia, Cornell, Michigan University, or the less well known University of Vermont. Then, the way to work up a sporadic case of enthusiasm is to do something original along the line of research. If you live within access of the forest, there are problems under your feet which have never been solved, and of which you can give the solution. We know very little about the life of our everyday plants. I did not know for a long time that one of our most common, the jack-in-the-pulpit, on attaining its full vigor, changes the sex and from male becomes female. Your discoveries are not only interesting to you, but you would find that

there is no other field in which original observation can be carried on with so little previous training. Your laboratory is all out of doors. Now, if you want to work with enthusiasm and can not get where it is, take up the study for yourself with the best literature available. Tell the pupils of things you have done and read of.

Now you may have enthusiasm and work hard, and have enthusiastic pupils, and they may work hard, and yet they may not be able to pass examinations. I see examinations from a different point of view from many. At present our examinations test memory only. If our education is to do its proper work we must have examinations that test power rather than memory. It seems difficult to get up an examination that will test power. I can not say precisely how it should be done. Our business men claim that our teaching does not give power. As long as examinations test the memory only, and ability of pupils to pass in memory questions, so long shall we hear this complaint.

That our enthusiasm may not be dampened, I ask that examinations may be made up more with reference to this thought; then teachers will be enthusiastic, and persevere in enthusiasm.

If pupils have the power and desire to know more the teacher has done his work well, whatever the results of the examinations. The high school teacher should, doubtless, use the microscope, but it has the disadvantage that in most cases work with it can not be carried on outside of the schoolroom and must stop with the school course.

I believe in training the pupil so far as possible so that he will be able to follow the injunction of the poet to "go forth, under the open sky, and list to nature's teachings."

Prof. F. E. Lloyd—I am impressed by one point mentioned by Dr Grout, and that is, that high school teachers should be, to some degree at least, able to pursue original research in botany or zoology. It is coming to be one of the demands which may justly be made on high school teachers.

Section C. EARTH SCIENCE

GEOGRAPHY FOR TRAINING STUDENTS IN NORMAL SCHOOLS

BY PROF. A. W. FARNHAM, OSWEGO NORMAL SCHOOL

Before discussing the subject, geography for training students in normal schools, we must in a general way determine the place and purpose of the normal school. Its place is between the university and the masses. It is maintained by the people and for the people; and its purpose is to train teachers for more efficient service in the grandest of popular institutions, the public schools. Indeed, the graduates of normal schools holding certificates of scholarship from no higher institutions of learning than the normal schools, will, with few exceptions, find positions in the grades below the high school. The geographic teaching, then, of normal graduates, will cover the field included in elementary school geography.

Let us review the present status of geography requirements and opportunities in New York state normal schools. Their program of studies requires that students in training shall pursue geography the last half of the junior year and the first fourth of the senior year; in all, 30 weeks of daily instruction in 45 minute periods. The illustrative apparatus and material consist of ordinary globes, a not too bountiful supply of maps, one or more sets of raised maps, a modest collection of colored charts made from photographs, a few good lantern slides, and a comfortable working library. All this is good so far as it goes: it is excellent; but it does not go far enough. It does not meet the present demands of geography. How, then, would its efficiency be greatly enhanced? And in what should the "geography for training students in normal schools" consist? These two questions, from the writer's point of view, may be answered as one.

The more recent development and growth of the geographic idea, for want of a better term, has been called "the new geography." Dr Redway in his latest, if not his best published work, has supplied the better term: "the new *basis* of geography." He tells us, what we believe, "that a different interpretation of the nature and scope of geography is growing into the educational systems of the United States. Broadly stated,

this interpretation is the mutual relation of geographic environment to political history on the one hand and to economic development on the other." This interpretation is demanded of geography today. A better means of its interpretation would increase the efficiency of geography teaching in our normal schools, and would also more fully equip our graduates for their work in grade schools.

One of the first needs, after an efficient teacher, is that of a laboratory furnished with models and apparatus for practical exercises in physical geography. The work to be done in physical geography can not well be done in the classroom. The models and apparatus to be used can not have proper care and manipulation in the classroom. The geography teacher realizes that a laboratory is a necessity. To illustrate: a study of local weather is in part a study of measurements of atmospheric temperatures, of atmospheric pressures, of humidity of the atmosphere, of direction and velocity of wind currents, all of which must be determined by apparatus working under certain conditions—conditions that can not be found in the classroom. A study of rocks—their composition, relative hardness, and comparative resistance to atmospheric agencies—is necessary for the study of the soil, and is legitimate laboratory work. Mathematical geography is necessary work for the laboratory. The greater part of field work, which is now a necessity in geography teaching, is profitably supplemented by laboratory exercises. The use of government maps, now regarded as indispensable in the study of geography, is unsatisfactory in the classroom. That laboratory work and field work coordinated impress on the minds of pupils the reality of the various earth forms and their influence on life, is not the least argument for the establishment of the laboratory to further the teaching of normal school geography.

The second need is that of an additional program hour to be spent in laboratory exercises and field study. This additional hour is given to chemistry and to physics. Without it, chemistry and physics would largely be deprived of their practical value. With an additional hour, geography would be as greatly benefited as chemistry is or any other experimental science.

The third need is either that of a reduction of the number of

studies in normal schools, or an extension of time in which to pursue them. At present, individual student programs are made for from five to seven different subjects. It has to be explained that a student studying only four subjects has head trouble or heart trouble or some other serious defect. Life in the normal school is so "strenuous" that the one idea is to get out of the subjects, not to know them. Under such conditions teachers of geography, as well as those of other subjects, can not require of students as much time as the subject demands.

Here, then, is the most serious charge to be preferred against geography teaching in normal schools, namely, the lack of thoroughness caused by the student's attempt to do more work than can possibly be done in a given time. The result is superficialness and, what is worse, the belief entertained by the student that he knows a subject that still lies outside his mental horizon. Nor does his belief change to honest doubt till he attempts to teach geography. Then his energy is expended in getting subject-matter and holding in memory unassimilated material. His teaching, if it may be called teaching, begins and ends with the book. His pupils never learn from him that the hills and meadows, the streams and the valleys through which they flow, have related earth history, and that each earth form in their immediate neighborhood has had some influence on the settlement of the neighborhood, and also on the industries of its people; for every people will engage in those industries which will bring them the largest returns for their investment, and their geographic environment will largely determine for them what those industries shall be. For instance, the degree of slope is an important factor in determining whether farming or dairying will bring them the greatest commercial success; and also whether lines of transportation may be built with reasonable outlay to connect them with commercial centers, and later, perhaps, to make their locality a commercial center. The presence of water power and access to raw material may decide certain local manufactures. The pupils of a teacher whose geography is between the covers of a book do not learn that the study of the natural features of the landscape about them is a study of geography. How can they? The stream can not rise above its source.

Geography for training students is inadequate for the training students' mission, and will be till individual student programs are made so as to allow time for becoming more fully acquainted with subject-matter, through a wider acquaintance with geographic literature, thus giving the student such a broad grasp of principles that he will be able to teach geography and not the book.

It must be said that special method, or more properly, applied method, is disproportional to the knowledge of underlying subject-matter. Methods of teaching geography must be based on a knowledge of geography. The effort is often made to teach subject-matter and the method of teaching it at the same time, or "some of each" in the same lesson hour—a thing quite unpedagogic. It is not possible that one can give equal attention to a subject of study from the standpoint of the learner and also of the teacher at the same time.

The failure in teaching, when failure occurs, is oftener due to lack of knowledge of subject-matter than of subject method. And here let me say, the writer does not in the least degree disparage the value of methods of presentation, but he does believe that a somewhat thorough knowledge of a given subject must necessarily precede the method of presenting it.

Teachers will very generally teach as they have been taught. If students in training could have sufficient time, outside of the recitation period, for field work, laboratory work and library work, their methods of learning would serve them as methods of teaching. That method is the right method that leads a pupil to observe, compare, relate; that begets a spirit of inquiry and investigation; that enlarges his horizon, makes learning perennial, and increases his own usefulness; that leads him to see that the realm of knowledge is one realm, that one subject of study can not be isolated from all others, and that no subject of study can ever be finished.

Is this an ideal method? Call it so. May it be obtained? Why may it not be obtained? Under less adverse conditions this ideal should be realized through normal school teaching—not of the theory of teaching, but the actual teaching of the subject by the regular teacher in charge.

With this ideal for the teacher's aim, school geography will not in so many cases be a Sahara; the streams of thought will not shrink, shrivel, and dry up in waste-filled channels, but will flow on with increasing volume, and unite in one grand trunk which will make fertile the region through which it flows.

GEOGRAPHY FOR TRAINING STUDENTS IN NORMAL SCHOOLS

BY PROF. C. STUART GAGER, NEW YORK STATE NORMAL COLLEGE, ALBANY

It is the purpose of this paper to defend the following theses:

1 The teacher of geography should first of all be a teacher, second, a teacher of geography.

2 The preparation of the geography teacher should, therefore, progress along two lines: (1) principles of method, general and special; (2) principles of geography.

3 A firsthand acquaintance with the facts of local geography is essential to the clearest understanding of the geography of the distance.

4 The textbook study of the facts of geography to the exclusion of observational work, with the interpretation of the facts, characterizes the teaching of geography in the larger number of schools of the state.

5 The greatest need, therefore, in the education of geography teachers in normal schools is emphasis on the value of observational work, its place and purpose, how it should be conducted, and its correlation with textbook work.

To begin with, then, the teacher of geography should first of all be a teacher; second, a teacher of geography. The lack of professional standing for teachers needs no emphasis. The fact was well set forth by Rice in 1899. We have physicists plenty and geologists plenty; but of teachers whose purpose in life is primarily to be teachers, not scientists, and whose energies are centered in education for its own sake, and not wholly in the tools of education, whose interest is in the pupil and not wholly in the subject-matter, we have not a plenty![1] Only recently in a conversation, the principal of one of the high schools of the state said to me that, after all, he had about come to the con-

[1] Butler. 1901. p. 104.

clusion that the "personal equation" is the chief factor in teaching. It was only another version of the "My method's the best for me" doctrine, the cut and dry plan which would not be tolerated for a moment in medicine, but which, somehow, seems to appeal to those who have never known anything better in pedagogy.

To be sure, the teacher must know his subject-matter. So must the carpenter understand his plane. The study of the subject-matter is as much a part of the preparation of teachers as is the study of education and method. Scholarship, in spirit and in fact, is absolutely essential, but the ability to teach is not implied by its possession. Special knowledge on the foundation of broad scholarship is as necessary in teaching as in law, medicine or theology. The idea that they are fitted to teach which is given young graduate students by the universities, just because they have pursued graduate courses in subject-matter, is a serious drawback in attempting to meet a demand for professional (pedagogic) preparation for teachers. The old maxim "learn by doing," so far as teaching is concerned, has been well brought into question by Payne (1898). If the experience of the past is to be of any value, the plan must be that of the old Greeks, "Learn, then do." Perfection of the art, as in any other profession, will be acquired later, and, if the teacher has a body of fundamental principles as a criterion for judging of his daily work, his future will offer to him opportunity, not only for experience, but opportunity to profit by experience. "Experience makes mistakes, and therefore is not the only guide, but must itself be guided."[1]

The primary duty of every institution which professes to do the work of normal schools or colleges, then, is to educate teachers, not to train them. To create a professional spirit by making clear the fact that teaching is not a performance that one can be taught to go through with as animals are taught to perform tricks, but a serious art based on fundamental principles, "the noblest of professions, but the sorriest of trades." It is one of the fundamental defects of normal schools, as Mace (1901) has recently pointed out, that they are attempting to do two things

[1]Mace. 1897. p. XIII.

at once; to give the pupil both matter and method at the same time, giving only a review, instead of the new view of the subject which the teacher should have.[2]

Let us now consider the teacher of geography. Here the greatest requisite, first and last and all the time, is a knowledge of subject-matter, combined with a knowledge of the principles of method. And this knowledge must be so broad and deep, and so abreast of the results of contemporary research, as to burst asunder the covers of any school textbook on the subject. The teacher who is unable to see, not only the day's lesson, but the work of the term, yes, of the whole course in its proper perspective, its relation to the subject as a whole, and to other subjects, and above all, to the life of the pupil, is poorly prepared for the serious vocation he has chosen. He must know the portion of the subject that he proposes to teach, not only from the standpoint of the pupil, but also from the standpoint of the teacher. This he can not do the first time that he pursues the subject. He must think it out anew with the class before him in imagination. He must know that with which the subject may begin, the way in which the subject-matter is to be presented, and the source of aid in such presentation, as field work, the topographic map, geographic monographs, reports, and periodicals. Both for his own sake and for that of his pupils, his resources must not be bounded by the limits of an introductory textbook.

The preparation of the geography teacher, therefore, should proceed along two lines. First, principles of method, general and special; second, principles of geography. He should be able to distinguish the study of method, which is the study of fundamental principles, from the study of "methods," which is a consideration of ways and means, devices, apparatus. He should realize that there are three factors in the teaching act, not two only. I have no sympathy with the doctrine expressed before this association two years ago, that "the training of science teachers . . . reduces itself to the formation in them of habits of serious experimentation, accompanied by reading and thinking about the subject to which they are devoting them-

[2]Cf. Harris. 1899.

selves." This is all very desirable, but the training of the teacher of geography or of any other science does not "reduce itself" to this. The teacher needs, in addition, to understand the fundamentals of method, such as the principles of interest, apperception, and self-activity. He ought to know the steps of an induction and their bearing on his work in the classroom. As a teacher he should think, not so much about the subject, as about the mental processes involved in thinking about the subject. His devotion should be to teaching first, to science second.

Second, the prospective teacher of geography should know that this science is no longer a description of the earth, but a serious study of one set of facts and their relation to another.[1] First, the facts concerning earth, air, and water, and second the activities of living beings. He should be impressed with the fact that the present state of the lithosphere, hydrosphere, and atmosphere is the result of a series of causes operative, some of them in the past, and some of them at the present; that these conditions are not permanent, and that in their turn they are the causes of other effects. Unless he has found out some portions of the subject-matter as the result of his own observations and inductions, he should consider his preparation lacking in its most vital point. He will find his whole manner affected in presenting to a class any part of the subject if he knows some part of it at firsthand. His work will be characterized with a vividness and conciseness, with a lively interest and a confidence that can be acquired in no other way.

It is not necessary for the teacher of geography to be a *Forscher*, as the Germans understand the term. If he has found out a fact or a relationship new to him, the desired purpose will have been accomplished as truly as though the fact were new to science. Portions of the work outlined by Davis (1898, 1900), Cornish (1897), Snyder (1899), and the speaker (1900), are truly research work as far as the pupil is concerned, and such exercises should be a part of the education of the teacher of geography.

This leads directly to the third thesis, that a firsthand ac-

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[1]Redway. 1901; Dryer. 1897. ch. 2.

quaintance with the facts of local geography is essential to the clearest understanding of the geography of the distance. This has been emphasized well in the writings of Geikie (1892), Davis (1898, 1900, 1901), and others[1] and needs only to be mentioned here. It is a corollary from the principle of apperception.

My fourth thesis is, alas, too easy to defend. The textbook study of the facts of geography, to the exclusion of observational work, with the interpretation of observed facts, characterizes the teaching of geography in the larger number of the schools of the state. I have taken a record of the preparation of my pupils for the past four years. These pupils are required to have had the equivalent of a high school course in physical geography before entering the normal college. I find from their records that over 95%, roughly estimated, have never been on a field excursion or had any other work whatsoever outside of learning what the textbook said. In other words, 95% of our high school pupils are studying *about* geography, while only 5% at the most are studying geography. The causal notion seems scarcely to have been hinted at in preparatory school courses. Similar conditions are described by Burrows (1900) who found that in 58 out of 121 schools the work was confined wholly to a study of textbook and map. No wonder that, when he inquired of these same schools if they considered geography of educational value, some of them replied, "Geography as taught at present has little value"; and "Of no educational value except as helping in history lessons"; or, more discouraging still, "You could not educate at all, in the sense of developing thinking powers, by geography."

I do not wish to be understood as considering that textbooks have no place in the teaching of the subject; but textbooks present generalizations which are mere words to the pupil unless he can bring to their interpretation some knowledge of the facts on which they are based. The problem, therefore, is how the teacher may equip the pupil with the necessary data by which he may most clearly apperceive the generalizations of the textbook. Time will permit only the merest outline of the work which the normal should endeavor to give the prospective teacher of geography.

[1] Kelton. 1897; Dryer. 1897; Dodge. 1899; Merrill. 1900; Tarr. 1898.

First, a study of types in the field. It was only 100 years ago that Playfair demonstrated the causal relation between streams and valleys, and thereby solved for the world a hitherto unexplained riddle. There is, perhaps, not a school in the state where this demonstration may not be repeated, where a type study may not be made of hills, streams, and valleys, their present condition, their development, and their effect on human activities and industries. The origin and mode of formation of soil, the phenomena of glaciation, and the activities of village and city life, with their interpretation, may be studied at first-hand in almost any school, and this work should form a part of the preparation of teachers of geography in normal schools.

Careful attention should be given to the use of the material gained by observation; first emphasizing the fact that generalizations or concepts are reached only through special notions or percepts, and, therefore, second, how the knowledge of the home geography conditions the clearest apperception of the geography of the distance. Illustrative material, such as maps, models, and pictures, should be discussed, and the pupil stimulated to form the habit of voluntary reading and observation. Ability to represent by diagram or other suitable drawings the geographic form studied should be required.

Some of the most valuable work, judged wholly by results, that I have been able to give consists in taking pupil teachers who have studied about geography in textbooks into the field, where for the first time they are brought face to face with some geographic fact. The observed fact is then converted into a problem, and the proper solution sought. Three excursions I have found to yield unusually large results, and, though they may not be wholly new, I will suggest them here, since they may be repeated anywhere in New York state. The first consists in the study of the origin and mode of formation of soil, as illustrated in an abandoned quarry. The second is for the purpose of studying the formation and development of valleys of erosion as illustrated in hillside gullies and then in the larger permanent stream. In the third excursion attention is given wholly to a consideration of the evidences of glaciation in the home locality. These excursions have disclosed the fact that the pupils who have had a high school course in physical

geography have little real knowledge and very vague images and ideas concerning the subject-matter involved. For them the out-of-doors globe does not exist. These excursions show also by their results what a world of new meaning the textbook and map come to have when viewed in the apperceptive setting which the field work makes possible. It seems almost trite to emphasize these truths any longer in our discussions, and yet the fact that pupils continue to come to the normal institutions in a majority of numbers without having had this work shows plainly enough that the subject has not been over-emphasized as an essential factor in the education of teachers. So late as 1889, in a book entitled *Normal Methods of Teaching*,[1] the subject of "methods of teaching" physical geography was thus disposed of: "Little need be said concerning methods of teaching the subject. The pupil will study it from a textbook and recite it." This would indeed seem humorous if it were not in reality so serious.

Prospective teachers ought to be more or less familiar with existing texts on geography, and know the criteria of a good textbook.[2] And last, but by no means least, there should be included the presentation and discussion of the most recent contributions to the science of geography and the pedagogy of the subject, to the end that the prospective teacher may be made to realize that the science of his teaching and the science that he teaches are not crystallized classified portions of knowledge, but living organizations whose most prominent characteristic is development and growth.

To state the matter concisely, normal institutions should be places, not where subject-matter is taught for the first time to prospective teachers, but places where one may learn how to make real to others that which one already knows. The ability to do this demands, first, that the teacher shall know as much as possible of his subject-matter at firsthand; second, that he shall know so much more than he expects to teach that neither the day's lesson nor the year's work will bring him close to the bounds of his own knowledge. He should find little in any ele-

[1] Brooks. 1889. p. 484.
[2] Blodgett. 1889.

mentary textbook on which he can not throw a flood of light from his own investigation and wider reading. And third, and most important of all for the teacher, he should understand the mental processes involved in learning his subject, so that, while the pupil is thinking the subject, the teacher can think the pupil's thinking of the subject. This will result in securing to the pupil the maximum of discipline at the same time that he is enlarging his knowledge and broadening his culture.

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[The third paper was given without notes by Prof. C. T. McFarlane, principal of the state normal school at Brockport. Prof. McFarlane emphasized the necessity of devoting special

attention to the relations of life, specially human life and occupations, to the environment, and expressed his belief that a knowledge of the physical controls of life could be taught as well by analyzing the life conditions of selected regions as by beginning with physical geography and ending with the life conditions dependent thereon.

The last paper was by Prof. Will S. Monroe, of the state normal school at Westfield Mass., who outlined the possibilities and necessity of teaching anthropo-geography in normal schools.

An animated discussion followed the papers, to which Frank Carney, of the Ithaca high school, Prof. Albert P. Brigham, of Colgate University, Professors Gager, McFarlane, Monroe and the chairman contributed.]

Section D. NATURE STUDY

WHAT IS THE MINIMUM NATURE STUDY TRAINING FOR A TEACHER IN AN ELEMENTARY SCHOOL?

BY SUP'T DARWIN L. BARDWELL, BINGHAMTON

The discussion of the minimum or of any of the requirements for teachers of nature study, practically supposes that one's mind is made up respecting the field of nature study. It is not my intention, and evidently not the intention of the originators of the program, to call for a discussion of that side of it. You will see that what I have to say will come out of an understanding of what is the proper province of nature study. I have in mind two lines of needs. In the first line of needs, one thing; in the second line of needs, more than one.

For the first. In some correspondence which it has been my privilege to have with teachers, directors and supervisors of nature study in different parts of the country, I received Christmas morning a letter from a supervisor of nature study work in one of the smaller cities of Ohio. He is new in that field, and we have had some correspondence regarding the work he is trying to do in that city. In this letter he said he found that the greatest weakness was the need on the part of his teachers of some experience in nature study itself. That is the first need I wish to emphasize—a need of practical, actual experience. So far as this vital experience is concerned, it is not much mat-

ter in what field it is obtained, but it must be in some field if the teacher is to be a successful director of nature study. A teacher who has never traveled outside his town can not teach geography in any but the very poorest manner. He must have had a wide range of experience, personal experience so far as it can be obtained, and his personal experience supplemented and augmented by what he learns from the experience of other travelers in wider fields. The same may be said of the teacher of nature study.

The second line is a basis of material information—facts—something that shall be a stock in trade, materials with which to work. Here I shall speak along three lines.

First, the teacher of nature study must have a fairly intimate acquaintance with the more evident phenomena of the weather and climate in the particular section of the earth in which he lives. It is a common saying that anyone can talk about the weather. Not everyone can talk intelligently about the weather. A fair understanding of some of the more evident facts controlling the weather is highly imperative. Something of an understanding respecting winds, atmospheric pressure, the laws which control the phenomena of erosion and deposit, is an essential portion of a teacher's stock in trade, if he is successfully to carry on this section of work, which it seems to me is properly classed with nature study. To this end, he needs to be pretty fairly familiar with the subject-matter contained in certain sections of any good textbook in physical geography and with the more manifest laws of physics, including pneumatics, hydrostatics, and heat. He needs to know beyond the possibility of question, why it is and how it is that a large body of water helps to keep the general atmospheric conditions more stable and the temperature more uniform throughout the 12 months of the year, than is the case in a section where there is no large body of water. He knows these things because he has investigated them to a certain extent, because he has carried on, in a limited yet true and effectual way, some little experiments pertaining to that sort of thing.

Another need is a vital, intimate acquaintance with certain forms of plant life surrounding him—in short, the old-fashioned botany. I have nothing to say in objection to the microscope

in the study of botany. But laboratory work in botany is not a *sine qua non* for the teacher of nature study. It may be a good thing, an excellent thing. It helps to widen the horizon, and may be used with considerable success, or it may be left out entirely and the teacher not be very badly handicapped so far as nature study is concerned. But it is highly imperative that the teacher shall have a clear understanding of a plant like the hepatica, its life history and the laws controlling its life; shall understand something pertaining to the method of inflorescence; in short, he wants to be on good speaking acquaintanceship with the hepatica type of plants. Then he wants to have his range large and his study intimate, so that he can pick up a new flower, belonging to the same family for instance, and by an examination of 10 or 15 seconds will be able to say beyond question that it belongs to the same family. He wants to understand the life and some of the properties and the value to men of some of the vegetables as they are found in this portion of the world. He needs to know how to look at the ordinary tree found in this region, and to see what it has to tell him as it stands by itself. It will tell him in an instant of certain laws. He should be able to tell clearly and at once certain of the great industrial values of certain classes of hard woods. These will be stock in trade, and from these he can amplify and enlarge.

He also wants to have a good, clear familiarity with the fauna surrounding him. He needs to have an acquaintance with a book like Hooker's *Natural History*. Get the study with the microscope, if possible, as that is excellent. It will greatly assist the nature study teacher in the grades; but I would much rather that one of my teachers should know the life history of the toad than to know the structure of the particular ganglion in the toad's anatomy which must be tickled to make the toad jump. Live animals he wants to become familiar with, and not dead ones.

In addition to that, he requires a more intimate acquaintance with certain families and certain types. A more extended study in a certain department, insects, for example, might be had. The same might be said respecting other classes, birds, for instance. It is not necessary, to my mind, that he should know birds and insects intimately, but, in addition to the general knowledge,

he should know something quite intimately respecting a few individuals of one of these classes. If it is insects, he should know pretty clearly the general laws of the best classification, so that, if he takes up an insect he has never seen, he will be able to tell the division to which it belongs. There is thus born within him a certain consciousness and power, reserved and actual, which comes from that kind of intimate acquaintance and which goes farther than we can estimate, which helps to arouse enthusiasm, and which makes the child walk safely and with a sure advance into other realms of which less may be known.

So he wants to know something of the life history of certain of the other forms of insect life, as they surround him: what is back of the particular event which occurs when the June bug, or May beetle, comes up to the window and asks to be let in after the lamps are lighted at night.

Have I made clear the field which the teacher of nature study wants to be made familiar with? If he is familiar with these things before he enters upon his work, well and good. If not, they should be made familiar. I have placed them as a minimum.

I am aware that many teachers and most excellent teachers come with less requirement than this, but I take it that it is not our business to encourage the employment of people before they are fairly well equipped to earn a salary. It is not our business to encourage the employment of people till after they know enough, and have acquired enough power to go ahead and work with a considerable degree of sureness and effectiveness. The inexperienced teacher has much to learn; the best have much to learn. But there must be a certain minimum or there is a vast deal of friction, loss of time and energy, and nervousness in worrying about results.

There shall be a basis of actual experience with something. There shall be an acquaintance with facts pertaining to the more evident phenomena of the world around us, including physical geography and physics; in botany, including a familiarity with the general characteristics of the more common types of plants, like the rose, buttercup etc.; and a similar study of the more common forms of animal life as they occur about us.

Mrs Mary Rogers Miller—The design of this program was not made entirely clear by the statement of the subjects in the printed form. Since the training of teachers is that part of the nature study movement in which I have had the greatest interest, I desired to put all of our attention on that particular point this afternoon. I wanted a basis from which we could work; so I asked Prof. Bardwell to give us his idea of the minimum training in nature study that should be required of a teacher before entering on her duties in any school. I had not in mind a teacher who was expected to devote her time to nature study; but the fact that we don't seem to be quite on the same platform does not make me unhappy. I told several people that I hoped we should not all agree, and that each might go away with a bee in his bonnet and something to think about for a year at least.

What I want to have you think about specially, if you will, is the teacher who is going to teach in your school, if you are a superintendent, and of whom you wish to require some nature teaching. What are you going to expect of her? Prof. Bardwell, I think, may have in mind a teacher who is going to teach nature study only.

Sup't Bardwell—I have not, no ma'am.

Mrs Miller—I am set right. We will go on with the next. My notion was that, after Prof. Bardwell told us what we ought to expect of the teacher, we should consider this question: Where is this person who expects to become a teacher in the future going to get nature study training? Where and how? I have selected for this part of the discussion several people in whom I have confidence. The first is Miss Elizabeth Carss of the Teachers College, New York. Miss Carss will tell some of the trials and tribulations, as well as of the successes of a nature study supervisor.

WHERE AND HOW CAN NATURE STUDY TRAINING BE OBTAINED ?

BY MISS ELIZABETH CARSS, TEACHERS COLLEGE, NEW YORK

The necessity for training in nature study can be seen by an examination of a large number of outlines of courses of study for elementary schools. In nearly all public and in a large number of private schools some kind of nature study is required.

The interpretation of outlines of nature study is often difficult, as only a few broad headings are given, and there is no relation between the subjects selected and the other work of the grade. This indefiniteness is frequently due to the lack of understanding of the educational value of nature study in the school curriculum. The teacher is usually left to interpret the course for herself, and, unless she has the right training to help her in this, the result will often be unsatisfactory. When I say right training, I do not wish to imply necessarily a long specialized study, but rather some intimate knowledge of natural objects, as was suggested in the preceding paper on minimum requirements. The great difference between the demand made on the elementary teacher of nature study and the high school teacher of science is that, though nature study should have a scientific basis, it must touch on many subjects, and should serve to start within the children a lifelong interest in the world about them, while high school teaching calls for a clearly defined course in some subject, hence a thorough knowledge of the subject-matter.

If we grant that teachers should be fitted to bring nature into the schoolroom, the question naturally arises: Where can such training be obtained?

There are several reasons why colleges and universities can not be called the best places for training for nature study teaching. In the first place, the training of the professors and instructors is not that which would lead them to understand the needs of children of the grammar school age. In the second place, the work given in the universities is not accessible to those who are training to be elementary teachers. The great value of college courses in science is that they give scientific method of thought and work; and for those who, after years of teaching, wish to take up special supervision of nature study, such courses are almost indispensable.

Summer schools have aided many teachers who could afford to attend them. Nearly all state agricultural colleges have opened summer schools, in some cases free of charge. Among the larger universities that have definitely announced summer courses in nature study are Cornell, Columbia and the University of Chicago. The value of these courses is that they enrich

the fund of subject-matter and give new method of work. The drawback to the value of the work is that the materials studied in the fields during July and August are not those that can be seen or studied in the school year. The summer courses do not usually suggest winter work, and the environment of the school in which the teacher is situated is often very different from that of the summer school.

Extension work done by agricultural colleges, specially by the bureau of nature study at Cornell, has been of inestimable service in directly stimulating the children through correspondence and in extending information and suggestions to the teachers by means of leaflets.

We must look to the normal schools for the large supply of elementary teachers, and should therefore expect to find training in nature study in these institutions. How is the demand met in general by the normal schools? After examining 60 catalogues, none of which was earlier than 1899, I find that without exception some course in elementary science is offered. Physiology is almost invariably required, and the aim, as often stated, is to fit teachers to give the necessary instruction required in the public schools. The courses given at the normal schools differ widely in character and may be classed under two heads: (1) those giving elementary science and laying no stress on application to teaching; (2) those making such application the main consideration. Under the first heading, the usual courses are, one half year each of botany and zoology, often the same amount of chemistry and physics, and frequently mineralogy or geology in addition. These courses are often elective, but sometimes nearly all those mentioned are required. It must be said that these courses, in some cases at least, fail to furnish the student with either suitable subject-matter or good method of work. In botany and zoology students are often given close analysis of parts or the study of minute structures before they have any acquaintance with the function of parts or with the environment and habit of the plant or animal studied. Under the second heading, where training in teaching is considered of greater importance, I have found the following plans suggested: (1) subject-matter taught in the grades to be studied by the normal students with daily observation of the school

work, also the preparation of lesson plans, and lectures in the history of science; (2) the subjects taught in science grouped under the heading, " nature studies ", including botany, zoology, physiology, chemistry, physics and geography; (3) elementary courses in science which aim to be guides for nature study teaching, with apparatus planned with a view to its value and simplicity for schoolroom demonstration; (4) courses in method of teaching elementary science as supplementary to regular science work.

From the observation of work in a number of normal schools and a knowledge of the preparation of many normal school graduates, the following general criticisms of normal school training in science are in a number of cases justifiable. (1) The work has often been so unscientifically presented that students have not an accurate knowledge of even the elementary facts. (2) Too many subjects are taken up in a short space of time, and this leads to scattering, hence students do not acquire the power of handling a new subject. (3) Nature study has not been considered as equally educational in value with other subjects, therefore, sufficient attention to its underlying principles has not been given. (4) The suggestions given in method courses for this work are often too formal in character and, when applied to the schoolroom, produce dislike for the subject among the children.

Teachers come to the elementary school in a large number of cases with absolutely no desire to teach nature study and with very little knowledge of how to go about it. Yet many school boards require it, and principals insist that it be carried on. Here the function of a supervisor of nature study is most important, for, if she understand her work, she may give teachers the very best kind of training for nature study teaching.

What are, then, the requisites for a helpful supervisor? Of first importance is a thorough knowledge of children and school work. (2) A good training in several sciences, more specially biology, physics and geography. (3) Abundance of original observation of the habits and haunts of animals and plants—the natural history point of view. (4) Thorough understanding of the educational aims and purposes of the subject. (5) Insight to understand how to help untrained workers and to utilize the

knowledge of teachers of experience and some scientific training. (6) Wide knowledge of books suitable to aid teachers and for children's reading. (7) Knowledge of how and where to secure material.

Provided the supervisor be thus well equipped, what is the work before her? In the first place, to outline a course of study that shall be suited to the children and to the locality, sufficiently flexible to permit of a certain individuality in the work of each room, sufficiently detailed for clearness, correlated with other subjects where correlation gives strength to all subjects concerned, and arranged, as far as possible, to avoid overlapping of topics from year to year. In many outlines I have found a direction such as the following: "During the autumn, study trees, buds, twigs, flight of birds, etc., for all grades". In one school I found three different grades studying the germination of the bean. The lowest grade of the three was interested, the others acted as if they were utterly weary of the bean and its germination. Children should not be kept back in nature study any more than in any other subject.

After the plan is made on paper, there comes the difficulty of carrying it out. To do this, the supervisor must first get the cooperation of her teachers. Meetings with all the teachers in a school may be held, and the plan of work thoroughly explained to them, and reasons given for the selection of topics. Suggestions from the teachers should also be sought. If possible, give talks on the educational principles, subject-matter and schoolroom devices of study. Meeting with the teachers of the separate grades is valuable; for here the outline for the grade can be specially discussed, difficulties answered, correlation of work planned for. The supervisor should occasionally give a lesson to the children and encourage them by taking interest in their work and the specimens in the room, and, if possible, occasionally conduct a field excursion to some neighboring locality. After the observation of a lesson by the class teacher, the supervisor can often give helpful suggestions, though tact and judgment are here necessary. The criticism should touch on important points or it becomes valueless. Material that is almost impossible to be obtained should not be required. In any

case, the supervisor should be able to tell where either pupil or teacher may get it, and in some instances should provide it. The task of supervision of nature study is a difficult one, requiring energy, resources and sound training in science. No one, however, has a greater opportunity to improve the work in nature study than the supervisor who comes in direct contact with teachers and pupils.

After one or more courses in elementary science, students in some of the normal school courses at the present time are assigned for observation and practical work in the school under the direction of the supervisor of nature study. If this work in the practice school is to be of any great value to the students, it should be carefully planned. The following arrangement has been found to produce some very encouraging results. The aims of nature study and the principles on which the work is based are fully discussed with the students, and a brief review of what has been accomplished by others in this subject, is given. As far as possible, both the merits and defects of various schemes are discussed. The outlines of nature study for the school in which they are to observe are explained. Before the observation, they are given instructions in arranging lesson plans, and are required to prepare plans which will show how they would teach the lessons they are to see, suggesting materials, illustrations, etc. The lessons are then observed, and a careful written report of them required. The students are brought together for a discussion of the preliminary plans and the report of the observation. In this way the student compares her work with that of the teacher, and points of weakness or strength in preparation and presentation of subject-matter, method of questioning, use of illustrations, etc., are brought forward.

After such observation, students are given a chance to become more intimately acquainted with the work, by assisting with it. They may be assigned to direct a group of children on a field trip or in garden work, if there be a garden. Students may also be assigned to special rooms, where they are to become acquainted with the children, and suggest ways of collecting and caring for living specimens of plants or animals in the schoolroom. Finally, the student may teach a series of nature lessons

in the room where most of her practical work has been done, and where the children are best known to her.

It is true that such a plan calls for a great amount of thought and labor, but, if carefully carried out, it will give the student an invaluable knowledge of the difficulties and possibilities of conducting such work, and will give her a means of measuring the result of her work with that of others. Errors can be directly pointed out, and valuable or original ideas tested.

Mrs Mary Rogers Miller--Among the various places where teachers are trained, we have training schools and training classes. If nature study is a good thing, and most of us think it is, or we should not be here today, we want to call to account some of these training schools and classes and ask them what they are doing to prepare their students to do the work we want done. Miss King is going to tell us what they do in nature study in a training school.[1]

Mrs Miller—Before we take up the third division of this afternoon's work, I want to ask Prof. Sheldon to speak of the normal school nature study.

Prof. C. S. Sheldon—I came here to get information and to get suggestions in regard to my work for the ensuing term. All I know at present with regard to nature study work as it has been done there, is that there is a class in nature method 20 weeks each term. It is repeated two terms in the year. Students are obliged to take the nature method just as they are obliged to take 20 weeks in geography methods. Twenty weeks are devoted to the preparation for the work of nature study. The conditions are more favorable than in some of the largest cities in several ways. We can go out during recitation period or with teachers in method class and observe for ourselves at any time when the weather is good, and return in time for the following recitation. Three quarters of an hour will give us a good basis for future discussions and plans. Teachers in the practice schools are not all of them, of course, teaching nature study at any given hour during the day. We generally select those to teach this work who have been best prepared and show the greatest interest.

[1] Miss King did not submit a manuscript for printing.

It occurred to me that there is one thing that sometimes I fear we, even as teachers of nature, forget, and that is that the main object in teaching to be sought for is not the imparting of subject-matter, but the creating of ideas in children, and to this end it has always seemed to me that the first requisite is a very live interest in the teacher herself. I say herself, for we have 10 ladies to one gentleman in our own normal school, and the proportion is increasingly larger in many of the normal schools today.

I am not prepared to make any talk on this at all. I was merely taking notes on the ideas presented, thinking I might be able to make some more definite changes. In the future, I may have more experience to guide me.

Mrs Miller—Then I understand that in the normal school and training school, students have a foundation of scientific knowledge before they begin nature study? That you plan to adapt what they have gained of science knowledge to the nature study teaching? I would like to know how it works out.

Prof. Sheldon—I wish to say that there is one difficulty in preparation. Many of the students in coming to us have evidently had their training in science elsewhere, and we are expected to accept a certain amount of such knowledge from other schools. Frequently we find that such knowledge is lacking, though they have passed the requirements in the Regents examinations. Such knowledge is lacking, and they are sent back into the work in biology to prepare themselves more thoroughly.

Mrs Miller—Is there no such thing as teaching nature without technical science? And is not a mistake made in teaching science without nature? I know people filled with science who seem to know very little of nature.

Prof. N. A. Harvey—Folks come poorly prepared in the subject-matter. I know it is not any credit to a teacher in any grade to complain of the work in the grade below. But many amusing things have come within my observation recently. One girl was going over to teach a class one day last month. I was walking with her, and talking about her work. She suddenly thought about something. She said, "Does the moon rise?" "Why," I

said, "yes, the moon rises." I think questions about the moon were involved in the subject she expected to teach. She said, "Does it set?" I said, "Yes, the same as the sun. Didn't you know it set?" "No, I didn't know the moon set." "Well, you have seen the moon in the sky?" "Yes, I have seen the moon." "How did you suppose it got up there?" "I never thought about it." That is a striking illustration, though it is no reflection on the intelligence of the girl. She was a bright girl.

In a class for the study of insects not long ago, one girl, one of our brightest students, said, "I can't find the sting of this bumblebee. I have looked on the head and I have looked on the wings and I have looked on the abdomen." "When you were teaching your class about bees, what did you teach about the sting?" "I taught that that was the sting" (pointing to the tongue).

A class were studying the katydid. They had all read stories and poems about the katydid. When it was first presented to each member of the class, I asked what the specimen was. At last some one said it was a katydid, and a murmur of surprise went over the room. One said, "I thought a katydid was a bird!" I asked how many thought so. Eleven in a class of about 50 thought that the katydid was a bird. That was true in three different classes where I inquired in that same day.

These things tell nothing about the kind of work that has been done in the high schools. They do tell about the condition of the pupils and the knowledge of the girls that come to us to teach.

I went into a class in the 7th grade one day. The teacher was teaching about a moth. She had a good plan and was presenting it in a good way. The pupils were not paying attention to the work. The reason for the lack of interest was that that same moth had been the subject for a lesson in a number of the lower grades, and they had lost interest in it.

Mrs Miller—We all agree that it is not the amount of information, but the training one gets from the finding out that is of value. Yet I wonder how many teachers can resist the temptation to "tell it" when they know it? It is one of the hard things to learn.

[Here followed an informal discussion of the subject, in which the previous speakers, and Prof. Spencer of Cornell and Sup't Young of New Rochelle took part.]

Mrs Milller—Mr Beach of Buffalo has a plan to present for teachers' nature study classes.

SUGGESTIONS FOR A TEACHERS CLASS IN NATURE STUDY

BY CHANNING E. BEACH, BUFFALO SCHOOL 23

The following brief outline of work for a teachers nature study class has been prepared with special reference to the teachers of city schools, and it will consider the class as a means of meeting those difficulties which confront a city school teacher when he attempts work in nature study.

Briefly, these difficulties can be arranged under two heads: (1) lack of knowledge, (2) difficulty in obtaining material for class work.

In introducing a relatively new subject like nature study into the school curriculum, we are confronted by the fact that many excellent teachers now employed have had no adequate preparation for giving proper instruction in that subject. Where nature study lessons are optional with the teachers, many still hesitate to begin because of their lack of knowledge. Others, having begun the work, feel the need of more assistance than can be derived from books. But a relatively small number of teachers can spare the time and money to attend the summer schools and obtain instruction there; and it is to meet the needs of these city teachers without interfering with their regular work that teachers classes in nature study have been planned.

The factors to be considered in organizing such a class are three: a well qualified leader, interested teachers, and the subject-matter.

The success of the class will depend primarily and chiefly on the leader; and it may be well to enumerate some of the qualifications for that position. He should possess a fund of accurate information regarding natural objects, specially their habits, life history, and environment; and a general knowledge of their scientific classification and nomenclature will be of service but not essential. The wider his range of knowledge the better, because nature study is not limited to any one of the natural sciences.

He should be thoroughly acquainted with the locality, that he may choose the best places for the field trips. He ought to possess the traits that make a good teacher. But, above all, he should possess a love for nature, that subtle instinct and finer feeling which swell the heart with thoughts beyond expression and draw one irresistibly into the open fields and whispering woods. This he can not impart, but fortunately it is contagious. Among the teachers in every city there is undoubtedly some one interested and informed in scientific matters who would be willing to aid his fellow teachers. The members of this association might give some of their time in this cause, as it will assist in the advancement of science, which is one of the aims of our association. If there happens to be a local scientific society, some of its members might act as leaders, or the society might be induced to take full charge of the work. If it be impossible to secure a leader who meets all requirements, it will be necessary to apply a synthetic method and get the best of several different personalities.

Let us consider, now, the class, its formation, composition and size. It may be begun on either side—the class may organize and choose a leader or a leader may appoint himself and advertise for a class. It would be better however if some organized society, or even the local school authorities, took the matter in hand.

The size of the class is important. If too large, time is lost, and the whole class does not get the full advantages of the work. If too small, the leader will be obliged to supply all the energy which keeps things moving. From experience in such a class, I think 20 are too many. Ten are a good number, enough to keep up the interest, and not too many for a good leader to keep together. In case the class should wish to visit a locality not accessible by trolley, the railroads will make a reduced rate for an organized party of 10.

Before discussing the plans for class work, it is necessary to decide what the *aim* is. As I understand it, our aim is a practical one, and it is to enable teachers of city schools to obtain material for use in their classroom, and to give them the knowledge and directions which will enable them to employ this material to the best advantage. If this practical side of the question

is well carried out, the more ethical aim will be acquired unconsciously.

To obtain the necessary material, field trips are necessary. The field trip must be carefully planned. The leader should be acquainted with the territory visited; and it is usually advisable for him to explore the spot a day or two in advance to make sure that specimens worth collecting will be found. He should decide in advance what will best suit the needs of his class, having ascertained that it may be obtained, and be prepared to give its most interesting habits and characteristics.

The apparatus necessary will depend on the material to be collected; but some receptacle for plants and insects, a pail for aquatic life, and a net for insects and for dredging are essential.

The problem of transportation usually can be met by using the trolley cars. On arriving at the chosen ground, the plan of work should be carefully explained, if it has not been done before, directions for collecting should be given, and attention be directed to the points of general interest, such as soil, environment, and general relations.

Then, having prepared his class, the leader will lead them to the places where the chosen material is, and see that each one obtains enough for practical purposes. The class should, at the same time, study the habits and characteristics of the plant or animal collected, and also note the environment, that they may reproduce that condition in the schoolroom as far as possible. A little care at this time will save much trouble and may prevent disappointment later.

It is impossible for anyone to explain all that may be seen in even an hour's trip through the woods and meadows, and that is the reason for emphasizing one particular point. At the same time, the leader can and should call attention to some of the delightful and interesting features which present themselves.

A bird's nest containing eggs or young, a squirrel or chipmunk chattering in the trees, a stately old tree or some humble insect, may afford an opportunity for the leader to give his class a bit of real nature study in the field. It is pleasant to sit down on a convenient bank and enjoy the beauty of the hills and meadows, the color of the foliage with its beautiful greens in

the spring and its splendid hues in autumn, the sky and clouds and to listen to some of our wild birds singing their sweet notes of freedom. All this is pleasant and profitable; but it should not prevent the accomplishment of the work planned, because a teacher can not arouse much permanent interest in his class of 40 or 50 children by telling them what he has seen, no matter how deep his feelings may have been; but, let him place before his class something they can see and study for themselves, then will those pupils share his pleasure.

When the work in the field has been finished, the class should be assembled, the day's work carefully reviewed, and directions for the preservation of material should be given. Saturday is the most convenient time for a class of teachers to make a field excursion, but the necessity of keeping the collected material 36 hours before using it is a great disadvantage. In collecting, this fact should be kept in mind, specially if flowers are to be gathered. If it be possible, it would be better to have the trip in the afternoon after school, but there are practical objections to that plan also, chiefly the question of time.

At this general summary of the events of the trip, the leader will have an opportunity to answer the questions which the class have to ask, and he is a wise man who can answer even a fourth of those questions.

This briefly is a plan for a field lesson. It should follow the same fundamental principles which underlie instruction in any subject.

Owing to the infinite variety of conditions which will be met on field excursions, I have not entered into the details of such a trip; but have tried to sketch broadly a plan which would apply to any field work, whether the object were to collect pollywogs or hepaticas. Yet it may be profitable to mention a few of the things worth collecting for use in the schoolroom and suggest some general lines of study for the class of teachers. The distribution of plant and animal life, noticing what things prefer certain conditions, as a swamp, hill, woods, etc., the effect of environment, which is very noticeable in plants; the struggle for existence; the action of the physical forces of nature; the relations of different forms of life, as exemplified by the familiar relation between bees and pollination—all these

and many others are fruitful subjects for study and observation, and are also practical.

In the autumn months the dispersion of seed and the preparation for winter are the most striking phenomena, and material illustrating them can easily be procured. Goldenrod, asters, the autumnal leaves, the berries of the bittersweet, or a branch of the thorn apple bush, as the children call it, etc., will beautify a schoolroom wonderfully. The dead and dry weeds, such as the teazel and the yarrow, are excellent for drawing lessons. This is the time of year to collect cocoons, specially the cecropia, to be kept till the spring. When the leaves have fallen, it is easy to find the nests of the birds, which have been so carefully hidden, and can now be taken and kept for use when the time comes.

In the spring the first excursion should be made as soon as the weather permits; and the roots or bulbs of some of our early wild flowers can be taken, and, if potted with a little care, the plants will blossom in the schoolroom. Hepaticas, squirrel corn, violets and trilliums take kindly to this treatment. It is an excellent thing to have a wild flower garden if the school yard permits.

Crawfish, insect larvae, newts, toads eggs, and small fish can be obtained for the aquariums.

But, in collecting, see to it that our rare and beautiful forms of plant or animal life are not exterminated; but choose, rather, those forms which are so abundant that the number taken will not affect the species unfavorably.

The Cornell leaflets for teachers are invaluable in this work and can be obtained with little trouble.

In concluding, let me review briefly what has been said. The class is for the benefit of the teachers, and its first aim is to meet their needs in a practical way. To obtain the best results, the class should be of a convenient size. The work of each excursion should be planned in advance, care being taken not to attempt too much. The plan should be pedagogic and, barring accidents, should be followed. The leader should see that each member of the class gets the full benefit of the work. The burden of responsibility will fall chiefly on the shoulders of the leader, and he must be chosen with care. If you can find a

guide whose experiences afield are wide and varied, whose knowledge is accurate, whose eyes and ears are well trained, whose tact and kindness are unfailing, one "who in the love of Nature holds communion with her visible forms", and to whom "she speaks a various language"—if you find such a guide, then are you blessed indeed.

Saturday morning, December 28

SECTION MEETINGS

Section A. PHYSICS AND CHEMISTRY

COLLEGE ENTRANCE PREPARATION OF STUDENTS AS VIEWED FROM THE SECONDARY SCHOOL MAN'S STANDPOINT

BY PROF. R. J. KITTREDGE, SCHENECTADY UNION CLASSICAL INSTITUTE

In dealing with this subject we may perhaps properly consider it under three heads: first, college requirements in physics for entrance and efforts of the preparatory schools to meet these requirements; second, physics as related to other subjects in the college and high school curriculum; third, certain comparisons between the scientific and classical methods of instruction, and suggestions for betterment.

First then, what are our colleges requiring for entrance, and what are the preparatory schools doing to meet these requirements? To answer these questions, I have examined the entrance requirements of some 20 of our leading colleges and the courses of instruction of a number of our preparatory schools. Some of the colleges have in physics no entrance requirements at all, as they have no scientific course, or at least nothing more than a very limited instruction in science. Some others demand one year of a combination of textbook work and laboratory work, as indicated in some one or several of the textbooks designated. Some require no laboratory work at all, but those that require it require a notebook with at least 35 or 40 experiments performed by the candidate. Where a list of special exercises is called for, the majority of the colleges ask either for the Regents list or for that of the National Educational Association, taken directly from the book of Hall & Bergen. In the former list we have 66 experiments, or rather groups of experiments, for many of them contain a number of subdivisions,

each one of which may be considered a separate experiment. Many of these experiments are elementary; but they give a fair list of the fundamental laws of physics, while they do not make sure that the applicant has actually performed any laboratory work. In the second list we have 61 experiments from which to select. These are in general somewhat more difficult than those of the Regents list, in that they require more costly or more intricate apparatus, though about half of them cover the same ground as those of the Regents. They omit some subjects usually placed in such lists, notably the pendulum and some of the simple machines as well as the more simple laws of strings in acoustics. Some things are demanded under the subject of electricity and magnetism that are difficult to perform and unsatisfactory, when performed. The demands can be classed as higher than the Regents' work, requiring, as they do, more maturity of mind for the handling. These two lists can however be so used by proper selection as to give a year's work that will satisfy both requirements. This is that which I have attempted in my own class work and with fair results.

Now what are the secondary schools doing? I find that they nearly all offer physics in their science courses and are thus in advance of the college requirements. They provide from one half year's to two years' work in physics and that in the latter part of the curriculum. The great majority of the secondary schools have one full year, combining textbook with laboratory work. So much for the subject of physics as we find it in the high school and as a requisite for entrance to college.

We reach the second part of this paper: How is physics related to other subjects in the curriculum of the college and the preparatory school? Let us take a comprehensive view of the case and see just what is being done along the general line of science. Scarcely two colleges, we find, have the same entrance requirements. Some require a science for entrance to all courses; some require three sciences for the scientific course; some two; some one; and some offer such a course but require no science at all for entrance. Indeed even a technical school, we find, that requires neither Latin, Greek, nor science of any kind for entrance. And the condition in the preparatory schools can hardly be said to be better than that in the colleges. In

order to make comparison the more easily in this matter, I have tabulated the subjects taught and the time in years devoted to each subject in a considerable group of our high schools and academies, as follows:

Physics	1	½	1	1	1	1	2	1	1	1	1
Chemistry	½	½	1	1	1	1	2	1	½	0	1
Physiology	⅓	½	1	½	1?	½	0	⅓	½	0	⅓
Physiography	1	0	½	½	1	½	0	⅔	½	⅓	⅓
Botany	½	½	½	½	1	½	0	⅓	0	0	⅓
Zoology	½	½	0	½	1	½	0	0	½	0	⅓
Geology	0	½	½	½	1	½	0	⅓	0	0	⅓
Astronomy	0	0	0	0	1	½	0	0	0	0	⅓

Though this is a limited list of the high schools and academies of the country, yet I believe that it gives a fair illustration of the general method that obtains in the secondary schools. We see that they are trying, at least, to do a pretty large amount of work in the sciences and are teaching in eight separate subjects, giving from one third of a year to a full year to each subject. There is one notable exception to this general rule, and that is in the school which gives two years each to physics and chemistry and makes no attempt at any other science subject.[1]

For comparison's sake, I have made a table also of the language subjects as taught in these same schools.[2] I have omitted English, as I take it for granted that most educators are agreed that English should be taught for four years in all the curriculums. We do not therefore need to enter it in the comparison. You will notice the unanimity in the requirement of four years of Latin and three of Greek with the option of two or three years each of French or German. I have failed to find any school, in the somewhat limited list of catalogues at command, that attempts another language. (It is possible that in some the Spanish may recently have been introduced.)

We all know that there are students who, so to speak, take naturally to the languages, as a duck to water. We know also that the reverse is true, that there are students who dislike the

[1]Since writing the above, I find that the high school in Chelsea Mass. offers four years of physics.

[2]This table was not received up to the date of printing.

classics and are fond of the sciences. Of course, we have certain students who are good in all subjects and others who are poor in all. The great majority, however, appear to have a special and natural appetency for some one or perhaps two of the great departments of knowledge: language, science, mathematics, history.

That the greater number of students take Latin is well known to all educators. Now the question arises: Is this because the students themselves prefer it or because they are otherwise influenced to take it? Latin holds, and has long held supremacy in the field. It is one of the most thoroughly taught subjects in our schools. It may be regarded as one of the more difficult studies. Is it the prestige of the Latin, or the impression of its superiority as an educative study, or the acknowledged ability with which it is taught, or the pressure brought to bear by parent or teacher on the student, or the inherent difficulty of the study itself—one or all these—that goes to influence the student in his choice? Much as a belt runs to the higher part of a pulley, so the student seems to tend to the harder and more thorough lines of education. This is of course natural to the better, the strenuously constituted class of students. But the fact remains, account for it as we may, that most students take the Latin.

I was speaking with a classical man not long ago about this matter. He said: "You science men don't know what you want." Perhaps we don't. Then we should find out. We should determine what is best for our department and clearly and unitedly make our demand for that best thing. How our classical friends would smile if we should lay out a course for them with one year for Latin, one for Greek, one for French, one for German, and a half year each for Spanish, Italian, Russian, Dutch, and then fill in what remains with science! Yet how does that essentially differ from their arrangement of our own science course? They allow a year for physics, chemistry, physiography, biology, etc., arrange for electives in as many more, and fill in with from one to three languages.

Why should not the scientific student ask and receive just as thorough and complete an education as the classical student? Is it because of any essential difference in the nature of the

subject? I much doubt it; indeed, I am impressed with the conviction that, if a person pursues a course in science similar to the present language course, he will come forth from that course in ability in his chosen field the equal of his classical brother in his chosen field. We promptly admit that some need special classical training. Not a word would I speak against that training. I am only speaking my word for a precisely corresponding scientific training. But there is this other distinctive class that demands the sciences and not the languages. Are not we who have these minds in charge for the next generation, wronging them if we fail to equip them thus in their chosen field? English should of course be taught the four years, as has been intimated, and the present intermediate and elective courses arranged for as now.

If we agree on this point, namely, that a course similar to the present classical course—science subject in place of language subject—should be provided for our science students, what science shall replace the Latin? I feel confident that no one will question the right of physics to this high place. If Latin is the mother of languages, physics may be regarded as the father of sciences. The tendency is already in this direction. In most schools physics has scarcely less than one year; in some it has two years; and in all schools and colleges it ranks as one of the most generally taught and best equipped of the sciences. Physics applies mathematics, makes the eyes observant, trains every faculty, and forms the natural introduction to all the other sciences. If it is thus rightly taught for the four years, it should help the student to a fine perception, a correct judgment, good sense in practical affairs, and genuine culture, all of which goes to constitute the educated man or woman.

We frequently hear a girl express the idea that physics is a proper study for boys but of little use for girls. This is not correct, however, for physics is of equal value to the girl and the boy. Yet a young lady of this sort who was in one of my classes, in answer to a question on the dew-point, said that, when ice water was placed in a pitcher, the little drops of water that formed on the outside were the dew-points. She also, in answering a question how much of an iceberg will be above the water, replied that, as the specific gravity is less than one,

it will all be above. Perhaps such a student is hardly likely to make a success in science, though she may do well in some other course of study. On the other hand, commend me to the young ladies for the best kept notebooks, and the neatest manipulation of apparatus. If the laws of momentum, for example, are shown to apply to the shaking of a rug, the laws of heat to the washing of dishes and to the canning of fruit, together with a thousand other practical applications, no cry of dislike is likely to arise from the female part of the class.

We are handicapped in the proper teaching of physics in a variety of ways. It is hard to find the teacher who is really well educated in this department. This difficulty, however, is becoming less, in fact all difficulties are lessening as the real value of science comes to be more and more recognized. It costs money too to equip a laboratory, yet I find that our boards of education, when they become acquainted and interested, are as ready to appropriate money for scientific purposes as for any other. It requires but a few years to equip a good working laboratory under judicious expenditure of a fair appropriation. The greatest difficulty I find in textbooks. There are plenty of them, such as they are, but some are too hard, some too easy, some are given to too much laboratory work, etc. The textbook of physics should be as the grammar of a language, as a book of reference, a book of laws and explanations. We do not ask a student in classics to work out a declension in Latin from a copy of Caesar's *Commentaries*, but from the grammar; yet some expect the student of physics to work out Boyle's law from experiments before he knows what Boyle's law is. We seem to compliment the young fellow highly by placing him thus about on a level with Boyle or Mariotte, but we do him injustice just the same. Should he not learn all he can about the law that he is expected to prove, the discoveries concerning the law since Boyle first stated it, and be familiar with the apparatus and the discrepancies he is certain to find, before he attempts to work it out for himself? That is, should he not know grammar and vocabulary before he attempts translation?

At present, little if any credit is given in college for the physics work of our secondary schools. Can we wonder at this when only a year is given to the preparation, and in that year

we hurry through the subjects of mechanics, heat, light, sound, electricity and magnetism? Could not the first year be spent with profit in learning the fundamental laws, acquiring ability to measure and perform simple experiments? Could not the second year be spent in the study of mechanics, performing more experiments of greater difficulty? Could not the third year be devoted to longer, more precise experimentation, with special attention to the subjects of heat, light and sound, leaving the fourth year for more advanced work in electricity and magnetism and the manufacture of apparatus? We would thus have a foundation for any of the other science subjects, and leave the colleges free to prepare the student specially for his life work.

In drawing this paper to a close, let us review the points touched on. We find no two colleges have the same entrance requirements in physics, and no two preparatory schools are teaching it in exactly the same manner. We find science wofully neglected in both college and preparatory school, the correlation poor between them, and a lack of maturity in the results obtained. We find the classics have reached a state of uniformity that indicates a stable condition; and I make the following suggestions: That we unite in seeking proper recognition for our subjects, that we have a scientific course in science similar to the classical course in language, that physics be given the same place in such a course as Latin holds in the other, that not more than four sciences be taught in the preparatory schools, and that the colleges arrange courses to correlate with these.

Prof. H. J. Schmitz—I would like to make a few remarks. First, I would like to protest against the idea of the scientific and classical education for the high school. What is education, and how can a scientific course differ from any other if it means the development of the boy or girl for life? If the ideal thing is to fit the young people for life, it can be done in one as well as in the other. It is a mistake to talk of scientific and classical education for young pupils.

I believe that every school should have an ideal of its own. What this shall be, depends on circumstances. There may be schools in which students want a commercial education. Others

which wish to prepare for college. But what are we going to do with the schools in general? The tendency is to fit pupils for higher power instead of for life. What should they demand? If a pupil has a general education, it is all that is necessary. The high school should provide this, and not aim merely to prepare for college. A course for the general benefit of mankind is what we want.

Prof. Charles F. Binns—We can regard the subject of physics as the foundation subject of every day school. And, in general, is it not a case of the "survival of the fittest"? Most of you know that it is difficult to lead any student into the higher branches of science unless he has an acquaintance with German and Latin. I know of professors who decline to take students unless they have a knowledge of Latin, this being the groundwork on which every language is based. In my own work, in clay-working, a student must understand German. It seems to me that it is no choice that Latin is selected as the leading subject in scientific education.

CHEMICAL LABORATORY NOTES

BY PROF. CHARLES M. ALLEN, PRATT INSTITUTE, BROOKLYN

Science teachers sometimes lose sight of the fact that many educators do not concede to chemistry and physics study an educational value equal to that of mathematics and language.

This educational discount is generally placed on any study which devotes a considerable amount of its time to laboratory work, which is considered with more or less justice as not demanding an adequate amount of effort by the student. The student, however, is the best judge of an easy or hard study; and I believe the average student will declare that a year's work in science, as generally conducted, stands for a decidedly less outlay of mental energy than a year in algebra or in Latin.

If this is true, I think it worth our while to seek for the cause of the unfortunate estimate placed on science study and if possible, to remove the handicap. It is, I believe, the character of the laboratory work which has brought science in our secondary schools into disrepute among many educators. If we will bring our science into good standing, we must stop "fooling with test tubes and playing with precipitates." Laboratory work should

be made more strenuous than it now is. Before a student or an educator will respect a laboratory course, he must see clearly that it demands strong, honest effort. If a teacher thinks that a student works as hard in his laboratory as in his classroom, let him make the announcement, "Today you will exchange recitation for laboratory work," and note the sigh of relief, and mark the contented smile that passes over his class. These evidences of joy are not due wholly to love of laboratory work, but are caused in part by the student's escape from the harder task of the recitation hour. The prevailing lax methods of conducting laboratory work and more specially the indifferent way of recording notes of experiments, are mainly responsible for weakness in chemistry and physics study.

The textbooks of chemistry with very few exceptions may be divided as regards their experimental provender into two classes.

First, *the flabby experimental book.* This is filled with a swarm of little, easy experiments which do not demand any decent amount of mental effort by the student. I can best illustrate by a typical experiment copied verbatim from a recently printed experimental chemistry. "Take a piece of ice. Note its properties. After crushing, heat in a 100 c.cm. flask. When all is melted, note its properties. Heat the water to boiling. Does anything escape from the flask? If so, state its properties. What are the three conditions of matter?" Now what is there in such an experiment that an ordinary boy or girl does not know before he tries it? You can not make a student respect such laboratory work as that. He will rightly conclude that it is a "snap," not worth his while to perform. Yet this book is published by a very respectable firm A. D. 1900, and will doubtless be pushed into some schools.

Second, *the devitalized experimental book.* Experiments in these books are uninteresting to the student, because they inform him just what is to take place even to the minutest particular. There is a host of such books on the market. I turn at random to an experiment in a chemistry textbook which, aside from its experiments, is a most excellent book. "Prepare some starch paste and dilute five or six drops with 10 c.cm. of H_2O. Dissolve a very small piece of I in alcohol and add a drop of the alcoholic

solution to the dilute starch. The starch will be colored blue. The blue color will disappear upon heating the solution and reappear upon cooling it." Such an experiment has had the life squeezed out of it by telling the student all that he should find out for himself. He can write the requisite notes just as well before he has performed the experiment, and this he will proceed to do unless watched. This verification of results predicted in the book offers nothing to compel thought, nor does it really demand anything better than careful manipulation.

There is no experimental book that is perfectly satisfactory to a teacher. Consequently, the only thing to be done is for the teacher to make his own. This can be done without undue trouble by means of printing hectographed or mimeographed sheets with experiments, selected, modified or originated by the teacher. Whether such a list of experiments may be called the teacher's own is an ethical question I will not discuss. The advantages of such a system are so many and so great that it certainly will appeal to all progressive teachers who have not yet adopted it. For this system the following advantages may be claimed.

1 A teacher may incorporate into his laboratory work at any time any first class experiment he may come across. Such experiments are constantly appearing in the new books or in chemical journals, or in such conventions as this, or, best of all, may be originated by the teacher. He may thus select those experiments adapted to his own classes and to his own laboratory facilities. Thus he has at his command an elastic series of experiments which he may cut and trim, amplify and strengthen as he will. With such a system laboratory work may be made strenuous, up to date, and worthy of a student's best effort.

2 The teacher may in a sense regard such a collection as his own. Nothing is so alive as the product made in whole or in part by oneself. There is a pride and interest in working out to success such a collection of experiments. This interest will spread from teacher to student; and the class will be vitalized with the thought that it is doing something which comes directly from the teacher's hand and is designed specially for its own use.

3 By increasing or decreasing the number of experiments, a teacher may keep his laboratory work coincident with his recitation work. I prefer generally laboratory work on most subjects to come somewhat in advance of textbook instruction. In some parts of chemistry I prefer the reverse. By this method a teacher may arrange this as he pleases.

4 There is a marked advantage in keeping the textbook entirely out of the laboratory. The average student prefers to hunt up in the book the answer to a question rather than to rely on the evidence of his own senses gained in experimental work. By using one's own laboratory direction sheet, this paralyzing tendency in qualitative experiments is corrected, and independence is enforced.

5 I have found a decided advantage in issuing to my classes a few sheets only at a time. Thus the top of the hill seems to be in sight and more energetic work results. A boy likes to report "Out of sheets". I issue not more than half a dozen at a time.

The only practical notebook, as most science teachers have discovered, consists of detachable sheets fastened in some sort of binder. It is only with such a book that a creditable record may be secured from every member of a class. With it, the carelessly written notes may be detached and rewritten, and the teacher does not commit the educational blunder of forcing a student constantly for a year to view the results of his own carelessness. This notebook with detachable sheets is adapted admirably to the system of instruction sheets here advocated. Among its advantages the following may be noted.

1 In the exhausting labor of correction of notes, at least one third of the time is occupied in collecting, handling and distributing the notebooks and turning over the leaves to find the place for correction. This time is saved when one has at hand, in a bunch, the file of detached sheets to be corrected. But what a relief it is for a teacher rolling up such a collection to be able to take it where he pleases for correction and above all to possess the blessed assurance that these notes do not necessarily have to be corrected before the next laboratory period of his class.

2 It is only by using such a system that a teacher may be absolutely sure that independent work has been done, and that he can with a clear conscience certify such notes at the end of the year. There is no need of emphasizing the crying need of honest, independent laboratory work. This kind of work can be secured only by insisting that all notes shall be written in the laboratory, during the laboratory period, and that they shall not leave the laboratory except in the teacher's hands. Such notes should be written in ink, thus saving time and at the same time teaching the student the important lesson of making his first draft his final one. When a serviceable fountain pen may be obtained for a dollar, there is no need for penciled scribblings.

The notes detached from the binder and handed in for correction, when "accepted", I think it wise to retain for a month or a half term, or till examination time calls for them for the student review study. With these precautions the teacher may surely affirm that the notes are the student's own work. These notes may not look as neat, they may not be as elaborate, but elegant handwriting and beautiful sketches are not to be compared with true, independent work.

3 With the instruction sheets for each experiment bound so as to face the "accepted" notes for that experiment, we have at the end of the course a compact and complete record of all that was required in the laboratory and all that was done by the student. This is trustworthy evidence which, because it is easily examined, is accepted by the examiner as a record of real work truly done.

As regards the form of the notebook, I have found that a simple binder opening at the end rather than along the side is preferable. A large saving of laboratory desk space is thus secured; for the instruction sheet may lie on one cover that is leaned up against the shelf, which on most laboratory desks faces the student, while the blank sheet for the record may lie flat and convenient for writing. In this way, too, at least one half of the book is kept away from "acids, bases and salts" which occasionally float over the desk top.

The size of a binder may suit the teacher's taste and convenience. I have found most practical a simple cloth-bound binder

$8\frac{1}{2}$ by 11 inches, opening on the $8\frac{1}{2}$ inch side. This has the eyelet holes near the two corners, and the sheets are bound in by long brass McGill fasteners. This is simpler, cheaper and better than any patent fasteners. These, I have found, either tear the sheets or get loosened by use. Any bookbinder ought to furnish such a binder in cloth, quarter leather, for 25 cents or less.

The sheets of paper used are standard letter size, $10\frac{1}{2}$ by 8 inches. A single sheet of this size, by using both sides, I have found large enough for recording an ordinary experiment.

I prefer unruled paper. It is neater, and students should learn to use such paper. The sheets of the record may be made attractive by bearing a printed form, providing spaces for date, number of experiment and name of student at the top. A space occupying vertically a half inch may be devoted to "Required." This includes the title and a phrase describing the object of the experiment. I have found that a space of $2\frac{1}{2}$ inches is sufficient for a concise statement of "Process." For a student to condense a description of the essential things done in an experiment, and limit it to this space, is both a valuable lesson in English for a student and a relief to the examiner. Of course, if more space is needed for any experiment, it may be taken by lining out the printed word "Process," and writing it in below. The remainder of the sheet and its reverse are devoted to "Conclusions." The writing of these conclusions can be made very definite by the answering of a rather large number of questions interjected in the direction sheet. These questions are lettered consecutively, so that all must be attended to by the student. These are scattered throughout the experiment, and are designed to draw attention to its more important parts and to insure that the student understands what he is doing and why he is doing it. Thus is avoided the mechanical following of instructions which is the bane of very much laboratory work. By the independent answering of a dozen or more searching questions, most of which he can not answer till the performance of the experiment furnishes him the requisite data, and many of which are rigorous enough to start some reaction in the gray matter of his brain, we may make the laboratory work strenuous enough to win the student's respect and to demand from him some honest, intellectual effort.

The preparation of these hectographed or mimeographed notes does not occupy so much time as might be supposed. A sheet can be written from copy and a hundred prints mimeographed in three quarters of an hour. A mimeograph, provided with file surface for stylus writing, may be purchased for $22.50. From this ideal printing machine may be obtained sheets neat and thoroughly satisfactory. The hectograph may be used and is very cheap, though it is not as good. If the right kind of ink is used, and the printing is done rapidly, 200 copies may be taken with the hectograph. Here is a sample of the first and the 276th copy of a hectograph sheet, and the latter, as you see, is legible enough for practical use. These printing outfits may also be utilized for examination and other similar work.

I have no hesitation in affirming that the introduction of this system of chemical laboratory notes will be followed by a marked increase of interest on the part of the student in his work, and will do much to bring to a place of honor the work in the chemical laboratory.

Prof. E. N. Pattee—I agree with the paper of Prof. Allen, that the weak point in chemistry is in the laboratory work. Textbook work is well done, but the emphasis should not be placed there. I have yet to find a student who thinks that the work done in the laboratory is as effective as that done in recitation. If science teachers are to be recognized, we must have as good work done as is done in algebra, mathematics, geology, etc. Prof. Allen has not overestimated the importance of strenuous laboratory work.

Prof. Burchell—I appreciate the work of Prof. Allen. There is a question I want to ask. About 15 years ago, when my work was shorthand, I began a system similar to his; but, when I began to take up this work of science, I was reluctant to use as my own that which belonged to other textbooks. I want to ask how the authors feel toward those people who follow this plan of making up laboratory manuals of their own? What are our privileges and limitations in selecting that which we think is best from other sources? Is any injustice done to the people whose textbooks we use so freely?

Prof. Allen—I think, if we examine a list of 20 books, that we will find that four out of five of the experiments are common to

all chemistry manuals. No fault is found in these cases, and the writers of the books are not infringed on in any way. No law is violated nor any copyright. We must remember that the material is not selected for publication, but simply for class use. If desired, it may be quoted with proper mention of the source.

HOW TO MEET THE PROBLEM OF TEACHING PHYSICS BY THE LABORATORY METHOD IN SECONDARY SCHOOLS.

BY FRANK M. GILLEY, CHELSEA (MASS.) HIGH SCHOOL

Headmasters and others who have to do with the administration of secondary schools are beginning to question more and more seriously the necessity of special provision in time and division of classes for laboratory courses in physics. "Why," they ask, "should not a class in physics be of the same size and subject to the same hours as one in English or mathematics?" In some cases the questioning has developed into more or less active opposition to extended courses in science for which such special provision is demanded in the way of hours for study and recitation. The demand for smaller classes also has gone far to place science on a plane different from, and lower than, those occupied by other studies in the estimation of various school authorities.

When, however, such authorities proposed to put physics on the same basis as algebra and Greek as far as time allowance is concerned, teachers called the plan at once an absurdity. "With 24 or more in a section," they say, "a 40 minute period would allow us less than two minutes to each pupil." This comment touches at once the difference between the algebra class and the physics class. The algebra class is taught more or less as a whole, while the physics teacher looks at once to the amount of individual instruction he can give to each pupil. If the physics class could be taught as a whole, then, it might at once be put on the same allowance of time in the curriculum as the other studies. Many teachers will be inclined to say offhand that it can not be taught as a whole because the pupils will not "keep together." But why should they not be forcibly held together as firmly as are pupils in Latin? That a pupil could perform the work of an ordinary laboratory exercise in

the same time he occupies in his Virgil or Caesar class, few teachers would be disposed to deny. The problem is to get the entire class to grasp the exercise, set up the apparatus, and perform their work without waste of time. Experience has shown that study by the pupil of his textbook or laboratory manual before coming to the class is but slight help to that end. Neither does it always serve to have the teacher explain the construction and working of the apparatus beforehand. The only effective way of accomplishing a short hour laboratory exercise is for the teacher to indicate or perform each step of the work, and let each pupil follow him, performing each step according to directions. At first glance this may seem merely formal and a pure waste of time; the truth is, however, that it saves completely all the preliminary helpless handling of the apparatus which two thirds of the class always go through when left to a set of printed directions, a process over which enough time is often wasted to perform an entire exercise.

The teacher should begin by giving directions for the form of record, including name and date if desired, giving special care to the description of apparatus. For the last he should make a diagram on the blackboard and exhibit the apparatus itself, or perhaps an enlarged model. He should then give the directions for the experiment, whenever possible holding the apparatus up before the class and performing each operation as he describes. If the experiment is, for instance, "images in a plane mirror at an angle of ——", he will begin his directions for the exercise proper with some such directions as these: "Lay a sheet of paper with one corner at the center of a page of the notebook in this way. Set the two mirrors along the edges of the paper, so that they meet at the corner in the center of the page. Look in the mirrors. Hold a pencil between them. Count the images that you see. Cover one mirror with a sheet of paper. How many images disappear?" At this, or at any convenient point, directions may be given to write down the method of the experiment as far as performed, together with the observations taken. The teacher meanwhile may go about among the pupils, looking at their work enough to detect any prevalent mistakes or omissions. My own experience has been in this particular exercise that half the class will at some stage

of the work have their mirrors more or less off the lines. If at the beginning I notice one who has made this mistake, I say to him without calling him by name, and loud enough for the entire class to hear, "Are your mirrors on the lines?" If the rest of the class do not at once correct the mistake, call the attention of the entire class to the error and give directions for its correction. By this method most of the mistakes to which a laboratory class is liable may be corrected with little or no individual attention to the pupils.

The directions for the exercise might then continue somewhat as follows: "Draw lines in the books along the edges of the sheet of paper. Remove the paper. What is the angle at the corner? Replace the mirrors. Complete the title at the head of the exercise to read at an angle of 90°." At this point the teacher may find it best to go about the class and draw an arrow in each notebook between the mirrors. If the parallax method is to be used, the directions would continue: "Place a pin at the head of the arrow and letter the point A. Letter the right-band mirror M. Locate the position of the image you see in it by placing a long pin behind the mirror in such a position that the image of the long pin seems to be a continuation of the image of the short pin. Move the head sideways. Do the image and the long pin keep in line? If not, try the long pin nearer the mirror or farther away from it." Of course the pupil is not to be reminded of the fact that the large pin must be as far behind the mirror as the short pin is in front of it, but the suggestion, "Try it a little nearer" or "a little farther" to a pupil who is in error is perfectly permissible. As a teacher goes about the class, his eye, moving past the desks in succession, will detect at a glance the one who must try again.

"Make a circle round the point of the large pin," the directions continue. "What does it mark the position of? Letter it A." Perhaps beyond this point the questions need not be quite so minute, but this the teacher may determine from the character of his class. Opportunity should be taken now to inspect the work, praise it whenever possible, and assist those who always need assistance. The very rapid pupil, or perhaps one who is trying to "show off," will very likely have made some error and have to go over his work again. In most cases

it is better that he should waste his time than that he should call the teacher away from the class to answer his conundrums. If time remains, dictate problems, some to be handed in at once, some to be done outside the class. Let those who finish the exercise first, study the diagram in the notebook and find some rule by which the third image can be located. Ask, for instance, how far it is behind the righthand mirror. How far behind the lefthand mirror. What happens to the third image when the angle between the mirrors is decreased. Suggest a way of setting mirrors at right angles. Draw lines at right angles and locate the third image of a point between them.

It is easy to continue along these lines with experiments that will be found useful as supplementary or review work on this exercise. Let the pupils fold a sheet of paper making the crease from the corner for an angle of 60°, and setting the mirrors by it at that angle, and count the images in them of an object placed between them. Let the rapid workers experiment with angles of 45°, 30°, 22½°. Arrange the results in some such tabular form as:

Number of images	Angle between mirrors	$\frac{360°}{\text{angle}}$	Number of images + 1

In the case of very young pupils, if the work outlined is divided into two or more exercises, in one of the cases described, set between the mirrors a card a centimeter high, marked on one side. Then all the images of the mark will be reflected first from the mirror facing the mark. By these methods that I have been outlining, it becomes a simple matter for the teacher to establish at the beginning whatever connection there may exist between the exercise he is taking up and the exercise that preceded it. If the exercise following the one just described is on parallel mirrors, let the class begin by decreasing the angle between the mirrors from 45°, five degrees at a time, and reporting the effect on the number of images. Finally, setting the mirrors parallel, let them locate by parallax method a few images in each mirror, and try to find a rule for their positions.

The first objection that will be urged against this method for laboratory classes is that it is mechanical. In theory it may

appear so; but one has only to try it to find in every exercise a point is reached before the end of the hour when the pupils may be left to finish the exercise by themselves, and often they will have time left to repeat it, or try some variation. Often too there is time left for a short explanation or experiment by the teacher, or problems and oral questions—and problems dictated at this time to be done outside of the class are often a valuable reminder to the pupil that there is another lesson coming. The teacher working along these lines is left free, instead of being at the call of every upraised hand, to pass around the class and see for himself whether the directions are being obeyed or not, and give directions for the remedy of any prevalent mistakes. He may do particularly effective work in criticizing the form of record. Such a criticism made without calling the pupil by name will usually take effect on half the class.

It is better to give 80% of your pupils an hour's instruction than to give 100% of them one minute. The choice is between the method we have been describing, that of one teacher one class, or the more common method of one teacher and one pupil; for, no matter how small the class, the individual method leaves out all but one. The method of having all the class at work at once, each on a different experiment, is the worst of all. It saves apparatus to be sure, but it wears out the teacher, who can not handle his class as a whole on any point whatever during the hour.

In more complicated exercises the method I have been describing will be found equally effective. Let us apply it, for instance, to the Wheatstone bridge experiment. Suppose the class already acquainted with experiments on the fall of pressure along a pipe carrying water, and the flow of water from a point of high to a point of low pressure. Suppose them, too, to be familiar with the fall of electric pressure along a wire carrying a current, and with the fact that this fall of pressure increases as the resistance increases. When they are supplied with the usual apparatus, and a one ohm wire or coil, and a wire the resistance of which is to be measured, give them directions step

by step, for connecting the battery, galvanoscope, and the known and unknown resistances. After each step is indicated, lines and letters should be added to the conventional lozenge-shaped diagram of the bridge, and to another diagram showing the form of bridge actually used. It is well to have the unknown resistance a little more or less than an ohm, so that the slider is near the center of the bridge when the galvanoscope shows no current. Tell the class to move the slider within 20 cm. or so of the righthand end of the bridge-wire, and ask them which way the N end of the galvanoscope pointer turns. Then let them move the slider to the other end of the wire, and then try to find the point that is at the same potential as the junction of the known and the unknown resistances. When this point is found, let them record the position of the slider. Now take the data of some one pupil and work out the unknown resistance on the blackboard, and the pupils can at once do the same with their own data.

Up to this point the class has worked together as a unit. Now let each go his own pace. To keep them profitably busy, use a two, five, or a one half ohm wire as the known resistance, and let them find whether the computed results for the unknown resistance agree. Let them find the resistance of a cell, a battery carbon, a miniature incandescent lamp (cold), a telegraph sounder, a telephone receiver, a transmitter, the primary and secondary coils of an induction coil, a commercial transformer, an electromagnet, coils of galvanoscope and galvanometer, ammeter, voltmeter, a dynamo armature and field, a thread of mercury in a tube (old standard ohm). If all this is not enough to keep an eager pupil busy, try interchanging the battery and galvanometer. Other exercises might take up specific resistance, and the effect of temperature on resistance. It is only necessary to get the class as a whole started on the right track, so there will be no need of telling each pupil separately anything that can be told to the class as a whole. Before long a class that has been taught by this method can safely be left to itself in the performance of exercises described in the textbook

as the training they have had in following instructions dictated to them step by step will serve them well in following printed instructions. Indeed, the necessity for instruction varies greatly with the nature of the subject, and the same is true of laboratory work itself. The management of classes in physics would be greatly facilitated if the fixed divisions of the time into lecture, recitation, and laboratory work could be done away with. In such a subject as light, laboratory work should occupy a large part of the students' time, while the laws of motion may be studied with scarcely any.

While these matters I have brought up, I have meant to apply chiefly to large schools, still, where the classes are 10 or less, the method of instruction may be modified in the case of a few exercises in which it is possible to make one or two pieces of apparatus suffice for the whole class. In such cases the class may gather around a good-sized table, and one pupil after another perform the essential parts of the experiment. The apparatus should be assembled and taken apart several times, and the pupils should both do it and see it done. Each pupil may take his own readings. Suppose that, in testing a thermometer, only one steam boiler is available. This should be steamed up while each pupil is taking the melting point of ice. Then the thermometer should be warmed in the hand or mouth (perhaps incidentally taking the temperature of the body), and put into the steam dome of the boiler. While waiting for their turn, pupils may read the barometer, figure what the true boiling point should be and make a diagram and description of the apparatus. One composition of force board will keep a class of 10 busy, the dynamometers or spring balances being held in position by clamps. After all have made readings and diagrams of the apparatus, some changes may be made in the forces and their points of application, and a new case recorded.

If we are to give physics its place as the chief and fundamental science study in large schools, there are needed, in addition to the reforms we have been discussing, convenient labora-

tories, suitable apparatus and trained teachers, who are allowed time both in and out of school for preparation. Assuming that there has been allotted to the physics teacher sufficient laboratory space (and this is far greater than is generally provided by the architect), the next problem is to obtain good working apparatus, one piece per pupil for each experiment. As an appropriation sufficient to provide apparatus for the entire list of exercises in the course is seldom made at one time, it is generally best to use the money as far as it will go in procuring enough apparatus for a few exercises and teach by the laboratory method as far as the apparatus will allow. Since some of the simpler apparatus may well be made by the teacher, a part of the appropriation should be spent for tools and raw material. The cost of stock for a set of apparatus for 25 quantitative and several qualitative experiments covering the subject of light is less than $1 a pupil. And this estimate includes a few things, lenses, prisms, etc., which the teacher would not dream of making. The lack of equipment should not stand in the way of an *introduction* of the laboratory method of teaching physics. In asking for an appropriation, the argument might be made that a city or town that can afford to employ a science teacher can not afford to fail to supply that teacher with tools of his trade.

However small the annual appropriation, a constant attempt must be made to increase the equipment, and in certain portions it should be complete, with apparatus for the individual pupil. Whatever is the size of the school, there should be an appropriation for physics just as surely as the seasons come round. It is not the best course to spend this all in one lump sum. Several times a year the way should be open to buy supplies as they are needed. Is there a large business anywhere in which the year's supply is contracted for and purchased at one time? Some department of the national government perhaps. You all know what is the effect there on the cost of production and the time of completion.

The class laboratory method, then, requires a complete equipment for any exercise attempted, spare periods during school

sciences. The first is classification, or taxonomy, an important branch of knowledge; but, when it absorbs the whole attention, as it did less than 20 years ago, in our schools, it gives but meager results, as some of us know by experience.

The plan of mounting and labeling plants and animals was later largely replaced by the study of types or examples. This change was greatly aided in this country by Huxley and Martin's *Elements of Biology*, since followed by scores of other works. This led to a more thorough understanding of the structure of plants and animals, also of their relationships, than the examination of the external form with a view to classifying them. This study of types has been associated in teaching with evolution, though historically the latter is much the younger. In the study of evolution, variations in domestic and wild forms of animal and plant life and their adaptation to changed or changing environment and struggle for existence divided the field with embryology, where, working on the basis of von Baer's law, the attempt was made to reconstruct the ancestral types of the different groups of plants and animals. Today we may find these ideals, together with the physiologic one, separately or combined with each other in ecology.

Much might be said in favor of emphasizing the physiologic ideal, as plants and animals must be studied as living organisms to gain a full understanding of the many problems involved in classification and morphology.

As we always have the poor with us and often without any fault of theirs, so we have teachers of science whose highest ideal, in practice at least, is to get as many pupils through the examinations as possible, and to whom the teaching of old examination papers takes the place of something better. I said it is not always the teachers' fault, for they are often given insufficient time or equipment, and real science is not a subject to be swallowed whole and disgorged in chunks in an examination. Then there are cases where the school authorities, teacher or pupils, or all, may be unable to see any use in a subject which is not immediately useful and capable of being coined into dollars.

There are, unfortunately, among the university-trained men who are teaching in high schools or colleges, too large a number who consider the work of teaching a bore and who devote their time to their own researches. It is not intended to decry research, as it is of the greatest importance, but too great a devotion to it.

In elementary work, at least, the pupil is of much more importance than the subject; but there are those who are more disturbed if they can not present the subject symmetrically than they would be to know that they were developing in their pupils a positive hatred of the subject and the worst methods of study.

There are two principal methods of conducting laboratory work and many variations. In one, lectures and demonstrations precede the work of the student, and the time in the laboratory is devoted to the verification of the outlines furnished or of reference books consulted. In the other observation by the pupil, aided by brief and simple questions, is made the preparation for consulting reference books under the guidance of a careful instructor, who aims to help the pupil to help himself rather than to tell him that which he can see with his own eyes. This is followed by a class conference, where comparisons are made and notes taken to help in looking up the disputed points. Then the instructor can, by demonstrations and explanations, supplement the work of the pupil. Thus the pupil, with a nucleus of his own carefully sifted observations and with the interest generally aroused, attracts facts as a magnet does iron filings. The latter method requires however an experienced teacher to prevent discouragement and to develop the pupil's self-reliance.

The pupil who takes up a science for the first time after reaching the age of 15 to 19, as we often find the student doing in college, has in too many cases been taught to be the passive recipient of the ideas of the book or instructor. The book is to him a fetish. Many of us have undoubtedly seen some of these devotees searching (surreptitiously) for drawings or descriptions in some reference work and sometimes handing in pictures of an animal of a different species from the one which they were supposed to study.

The extreme method used by Agassiz in his training of investigators has unquestioned advantages in killing off weaklings, but is of little value in an unmodified condition for younger pupils. The pupil needs judicious guiding rather than driving or being left to his own resources. The teacher should be a lover of nature and devoted to truth for truth's sake; at the same time, he must not be too exacting of the beginner. As the work advances, more and more must be expected of the pupil; better description and more accurate drawings. One of Agassiz's mottos, "Study specimens and refer to books," gives in a nutshell one of the great principles of zoologic study.

It is a pleasure to watch each pupil for some glimpse of real interest and to make it easy for him to take a second and many succeeding steps toward independent work. Develop his individuality whenever possible. The laboratory and its appliances, together with the instructor, should be simply aids to individual development.

The influence of a single enthusiastic student in a class, who has good methods of work, is many times more powerful than that of the instructor. The more good workers in a class the harder it is for the indifferent to remain uninfluenced. The advantages of summer schools for the best student in a class of college students can hardly be overestimated, as during the succeeding year they are able to stimulate their associates by the better work and broader views which they bring back with them.

In the time usually allowed for zoology but few types can be studied; but the more or less superficial examination of many related forms and anatomic preparations as soon as the study of each type is completed will prevent the narrowness too often associated with the study of types alone.

Whenever possible, a living representative of each group, if not the animal dissected, should be examined; and for this purpose simple aquariums and vivariums are becoming more necessary.

In a few places salt-water aquariums are successfully maintained with the advantage that the habits can be studied by the beginners, and material for research kept constantly on hand.

There are differences of opinion as to whether the elementary work in biology should be the broad and somewhat superficial examination of many forms before the minute and rigorous study of the few or the methods should be exacting from the start.

The tendency, as you well know, is toward the so called natural history method, with less use of scalpel and microscope in the high schools. In all work personal observation takes the first place, followed closely by comparison and experiment. The spirit of investigation, with its judicial consideration of all the facts, should not be ignored, but, whenever and wherever possible, cultivated to the fullest extent.

Should we attempt to train botanists, zoologists, or physiologists? If so, we can but fail in most of the cases. If we are able to strengthen the enthusiasm, help to form correct methods of working and develop fair-mindedness, the few who go on to advanced work will be able to choose, each for himself, the particular field of work. There are dangers, on both sides, in too little and too much help for the learner. There should be no sharp transition from learning to investigating, be it in science or in life.

Prof. H. R. Linville—I am much impressed by one point of Prof. Morrill's, that is, the mistake of giving laboratory work wholly into the charge of assistants. The instructor who gives the course should also have control of the laboratory work and of the assistants.

Prof. A. J. Grout—May I ask whom Prof. Morrill means by assistant?

Prof. A. D. Morrill—A graduate assistant is what I meant. I have such an assistant that does all the work that can be given to him. He is there most of the time, and it works very successfully. I have studied his methods, and am satisfied with his results in botany.

Prof. N. A. Harvey—One thought came to me as Prof. Morrill was speaking about the changing ideals in science teaching. Perhaps I would better illustrate it by carrying the matter of

ideals into what I have seen applied in recent years. The time the reports of the X-rays experiments were being applied, college graduates, high school teachers, normal school teachers were all teaching X-ray experiments. And then wireless telegraphy became the fashion, and college graduates, normal teachers, and high school teachers devoted their time to that branch of science. At the southern end of Lake Michigan are pronounced specimens of sand dunes. Scientific men began to study them; then high school teachers knew about them; then the teachers in the high schools, normal schools and elementary grades began teaching sand dunes. All schools began studying sand dunes. They occupy a large part of the work in geography. It may be the proper thing to do; but I question whether that is the best ideal to set up and make the basis of the study of geography. Somebody in the Chicago University made special study of the Chicago plain; but since then, the university teachers, high school teachers and normal teachers are all studying the Chicago plain. I doubt much whether this ideal we set up is the best thing to do, and that everything we have done before should be discarded and the new thing taken up. Dr Cowles published an excellent paper in the *Chicago Magazine* on plant societies. Teachers are studying plant societies; universities, high schools and normal schools are studying plant societies. Whether the thing is eminently proper and should be taken up and made so much of, and whether the things we have been doing previously should be so discarded, I will not undertake to say. It seems to me that we have excellent opportunities to use common sense. Science means common sense.

Prof. C. W. Hargitt—I want to say a word regarding one point, namely, the importance of a unified and harmonized outlook in the work of science teaching in college and schools. The paper called attention to the fact that sometimes the departments become differentiated, and perhaps lose their common point of view: the department in botany perhaps, or in zoology, or in physiology, where, exercising his interest in research along one special line, and ignoring nearly every other part of the biologic

work, the teacher may make an unwise distinction. I believe that both for the college and the high school, the idea from the point of view of general biology is a very valuable one, and one which we ought not to discard. And the teacher can be trained with the ideal that there are fundamental results to be obtained, and that his teaching may not lose sight of that principle. We can get more harmonious work than if we start out with the idea that physiology is the only thing in biology; that botany is the only thing in biology, etc.

Now it seems to me that the point raised by Prof. Harvey is not a very serious matter, providing there is a broad foundation back of it, i. e., that there is more in physical geography than "sand hills;" that there is more in geology than the "Chicago plain." I suspect that one of the troubles is that there is lack of proper balance. That is a tendency in these days. However, when we are brought face to face with the sand hills, here is something concrete and directly at our hand. We don't have to travel to study. The fault in the past in such work is that teachers have been led away into Europe, the Adirondacks, the Rockies to get illustrations; and, when the college professor brings them face to face with these things at their own door, they have lost sight of the balance—the relation these things sustain to the entire realm of nature. The danger is not in taking lessons from things at hand, but in not having a foundation back of them that will put them in their appropriate relations. The fault is not in the system, but in its proper adjustment and application.

Prof. F. E. Lloyd—It appears to me that educational fads are not altogether to be deplored. In following a fad for a time, we may at least believe that a teacher gets many new ideas, becomes acquainted with new points of view, and with new lines of thought. A teacher who may be accused of following a fad may not at any rate be accused of being asleep; and on the whole he is better off for the stimulus. We may have no doubt that the pendulum will swing back again, leaving little or no harm done, and, not improbably, considerable good.

Prof. Morrill—We can help the teachers in high school by suggestions. Suggest changing, and at one time giving wireless telegraphy, and at another time something else. The board may be very anxious that pupils shall understand wireless telegraphy. In that case I should use every effort to persuade the board to let me have more time, and use it for other purposes, and more than that get more money out of them for what I considered the real thing.

Prof. E. B. Callahan—The reason why teachers are so liable to copy the work done by advanced teachers is that they have had poor preparation. As you know, laboratory work in the sciences is a new thing. I think you will find that the teachers of the high school are giving you the highest kind of praise when they copy you; and they follow the investigation of the sand hills because they think it is the best thing to do. The teacher who has a good preparation before he gets into the high school can see the relation very well and is not so liable to copy.

THE TRAINING OF A SCIENCE TEACHER FOR SECONDARY SCHOOLS

BY PROF. N. A. HARVEY, CHICAGO (ILL.) NORMAL SCHOOL

It is easy to say what a teacher should be. He should have all of the virtues and none of the vices of the greatest men. The dignity of Washington, the generalship of Napoleon, the wisdom of Franklin, the statesmanship of Webster, the sympathy of Lincoln, the eloquence of Phillips, the scholarship of Gladstone, the business ability of Morgan, all of these things enter into the make-up of the ideal teacher. But, when a man is found who possesses any small proportion of them, he becomes unavailable for teaching at $60 a month, and is made president of an insurance company, or railroad, or a trust. So our teachers are not and will never be ideal teachers.

In a high school the teachers must be the very best that are available. I feel sure, notwithstanding the prevalent opinion to the contrary, that the high school period is the period of the greatest influence in the life of a pupil. It is a more important period than the period of elementary education, for it is at this

time that the outlook of the pupil on life becomes enlarged beyond his immediate surroundings, and he begins to plan for his life work and to adopt life policies.

A teacher of science in a high school ought to know three things: first, his subject-matter; second, the psychologic movements involved in learning the subject; third, the principles and the art of teaching.

No one questions the necessity of knowing the subject. No one admires the fulness and clearness of information that some teachers possess more than I do, though I think there is a tendency at the present time to lay so much emphasis on it that we are inclined to exclude other things of equal importance. Other things being equal, the greater amount of knowledge that a teacher possesses, the better he will teach. It is an evident impossibility for a teacher to know the details of his subject throughout its whole extent, but he must have such a knowledge of it as to furnish a background for the particular phases of it that constitute the material for class study. His knowledge must be much more extensive than he expects his pupils to have after they have finished their work with him. There is no better way of learning a subject than by teaching it, and every teacher must be in the attitude of a learner as long as he teaches. I would suggest a possible error, though there may never be any occasion for the caution I present. I question the wisdom of a teacher carrying on a line of study that is foreign to the work of his class, or that is only remotely connected with it. There is always so much connected with the subject that the class is studying that the teacher does not know that there is abundant opportunity for the exercise of all his powers, and his study is then directly beneficial to his class. So I should not expect a teacher to know every fact in the whole range of experience before beginning to teach. A part of his energy would better be devoted to something else. The teacher of botany must be something more than a mere botanist. He must be a teacher, and he must be a man.

We have heard much in recent years of the necessity for the teacher's being an investigator. The justification for this opin-

ion is the belief that research work has a greater educational effect on the mind of a student than the ordinary acquisition of knowledge. It can not rest on the assumption that there is not already sufficient knowledge in the possession of the world to furnish material for teaching, nor that the teacher has already learned all that is known in the whole domain of science.

I believe as strongly as anyone in the value of research work. I would have every exercise an exercise in research or productive of the same kind of value. This is easily possible if the teacher keeps textbooks, reference books and lectures out of the way of the class till they have had an opportunity to exercise their powers of investigation on the problems that the teacher sets before them. Where a teacher lectures to his class about the subject yet to be investigated in the laboratory, or assigns lessons from a book before laboratory work on the same subject is undertaken, none of the value of original investigation is possible. But I find this plan recommended in some books of high reputation.

On the other hand, some teachers in high schools are so imbued with the spirit of research that they set their high school students to work on research problems, believing that thus they are conforming to the most progressive ideas of education. To students of this age, with no more training in methods than they have had and no more knowledge of what others have done and said in similar lines than they possess, the conditions are identical with that of a class under the instruction of a teacher who is wholly ignorant of the subject of instruction.

The difference in the two cases is simply this. In the first case, the teacher knows what the pupil is trying to do, what result he expects him to get, why he wishes the pupil to do the work, and the place in the scheme of instruction that the work occupies. The pupil is kept from doing useless things; wasted energy and positive mistakes are avoided.

For three successive years I taught two classes in physics. One was a class of high school graduates who had studied physics with textbooks in hand and in laboratories of various

degrees of efficiency. The other class had never studied physics. The two classes were nearly of the same size, same age, used the same laboratory, same guides, had the same teacher, same apparatus, same exercises. In about seven cases out of 10 the class that had never before studied physics obtained a result that was more nearly accurate than was the result obtained by the high school graduates. The recurrence of this phenomenon for three successive years, under circumstances so peculiarly favorable for comparison, seems to justify the statement that the effect of textbook study in connection with a laboratory is to diminish the ability of pupils to obtain accurate data for use in the derivation of laws. I feel sure that textbook study in biology will have a similar effect, though the proof of the proposition will be more difficult to obtain.

This discussion has somewhat encroached on the discussion of the other elements in the preparation of the teacher, for I believe that no one who has made a careful study of the content of the subject and the principles of teaching will be led astray to the degree that I have indicated. At least it seems to me that we have in the above discussion an example of the necessity for the preparation of a teacher in other things than subject-matter.

Within certain limits, all minds act alike. They have generic characteristics in common. There are general laws of mental action that lie at the basis of all our attempts at education. Education would be impossible if it were not for this common basis of thought. A teacher, whose business it is to incite the mind to act and to employ its self-activity, must from the nature of the case know what are the laws of mental action and growth. It is not enough to know in a mere theoretic way what psychologists have formulated concerning the operations of the mind. It is necessary to know how to bring the mind of the child into the presence of the subject-matter in such a way that its activity shall be aroused, and growth result.

This is the thing which makes the difference between the teacher and the mere scholar; between the artist and the artisan

in school work; between the one who looks at the logical development of the subject and the one who sees the psychologic movement of the learner; between the one who teaches the subject and the one who teaches the child; between the one who gets his methods from a book and the one whose method is determined by the mental movement involved in education. The day has gone by when it is possible to maintain that knowledge of the subject is sufficient preparation for teaching it. There is just as much necessity for the application of pedagogic principles in the high school as there is in the elementary school.

Granting that good teachers do not just happen, we must allow that there is necessity for preparation. There are several ways in which preparation may be made. There are normal schools whose sole aim is to prepare teachers for their work, and they seem to be justifying their existence. As a strictly professional school, the normal school, from its very nature, takes precedence of all other kinds of schools for the preparation of teachers. The thing that a normal school undertakes to do is as necessary for the training of a high school teacher as it is for the training of a grade teacher.

It is commonly believed that the limitations of normal schools render them incapable of training teachers for the high schools, and that they should limit their efforts to the preparation of grade teachers. There is some justification for this opinion. In my own experience as a teacher of science in a normal school, I am unable to call to mind three teachers whom I could conscientiously recommend as teachers of science in a first class high school. It is true that many of my former pupils are teaching very successfully in high schools, but they owe little to the normal school for preparation in their special work. This condition is not inherent in the constitution of a normal school. The great demand on normal schools for the training of grade teachers and the relatively small number of teachers in any one subject demanded by high schools have rendered it inadvisable for normal schools to lay emphasis on the high school work. I think it will be admitted by everyone that, as at present organized,

normal schools do not give sufficient preparation for the teachers of science in high schools.

The next thing is to seek for teachers that have been trained in colleges and universities. This does not constitute an ideal preparation for the teaching of science. The college-trained teacher has some very serious limitations. In the first place, he is likely to be so wrapped up in the matter of his subject that he teaches the subject rather than the pupils. He is unconscious of the fact that teaching is anything except the imparting of knowledge. His teaching is likely to partake of the nature of the pouring-in process. He looks at the subject from the standpoint of adult logic instead of child psychology. His methods are likely to be copied without serious attempt at adaptation from the teachers in college; and in many cases these are known to be very poor models to copy from. In fact, in the absence of knowledge of the principles of pedagogy, it is a serious question if the great amount of detailed knowledge of subject-matter that he is popularly supposed to possess, and which is generally regarded as the one redeeming quality of a college-trained teacher, is not a positive disadvantage instead of a help. Comparing the college-trained teacher with a normal-trained teacher, it is a choice between two evils. Given one of the smaller high schools, in which one or two teachers do most of the teaching, and each teacher teaches seven or eight different subjects in a day (and this represents the greater number of high schools in the country) and I think the normal-trained teacher has proved himself decidedly superior. Where the school is of such a nature that the teaching of one person can be confined to a single subject, the limitations of a college-trained teacher are not so apparent. But so serious are they that I have been reliably informed by high school principals of much experience, that they expect, as an ordinary thing, the first two years' teaching of a college-trained teacher to be a failure. I suspect that every teacher who looks back at his first two years' work and who has attained a recognized proficiency in teaching, will be willing to acknowledge that two years are a low estimate.

It is true that the last few years have shown a rapid increase in the number of college-trained teachers that have been brought into the high schools. Observation of the fact in four states has indicated to me that this has not been from a spontaneous recognition on the part of school boards or school principals of the superiority of college-trained teachers, but has been brought about by a kind of influence on the part of universities of scarcely a legitimate kind, in refusing to place high schools on an accredited list unless they were provided with college-trained teachers.

There are three alternatives, or perhaps I ought to say four, by which better trained teachers may be secured. Two are at present available, and two need a modification of agencies already existing. First, normal schools may modify their constitutions in order to meet the demands for high school work. The plan at present under consideration for the Chicago Normal School is that the present two years' course shall be distributed over three years and shall be required of high school teachers just as it is now of candidates for the elementary schools; but in this distribution, there is an opportunity for the candidate to carry on a special line of work two hours a day for two years in the subject he may wish to teach in the high school. If that is biology, for example, there may be a proper division of this time among the following groups of subjects: technic, including the theory and practice of microscopy, microtomy, photography and projection; second, systematic botany, morphology, physiology and ecology; third, systematic zoology, morphology, embryology and osteology. The methods may include laboratory work, textbooks, lectures, readings, recitations, with special attention to the subjects that constitute an ideal high school course, and the psychologic movement involved in scientific teaching. It is not likely that this plan will be adopted. The additional equipment and expense would not be very great, but the number of teachers of biology demanded by the needs of the Chicago high schools is so small that it would be scarcely worth the effort.

The second plan is that universities shall so modify their courses in pedagogy that there shall not be the absolute divorce which now exists between the theory of education and the practice of teaching. So far, the pedagogic courses of universities have not seemed able to hold their own with the vigorous aggressiveness of the other subjects. There has been quite general lack of appreciation of the pedagogic courses by other departments, that has exercised anything but a benign influence on the teaching of university students.

Third, the teacher may get his knowledge of his special subject in the university or college, and his pedagogic training in the normal school. The normal school is a professional school, standing in this respect with the schools of medicine and law. We should expect that the best results would be obtained by giving the university training first, followed by the normal school work. In practice it is found that the reverse order works better. It makes a great difference in the teaching of a subject whether it is learned in the light of great educational principles, or whether it is viewed from a different standpoint. Students who are well grounded in the principles of teaching are able to see what is involved in particular methods, and are able to criticize intelligently the materials and methods offered in universities. On this account, I am reliably informed that normal school graduates are not always considered the most desirable students in universities.

It seems to me that the last is the most advantageous plan for securing better trained teachers for the high schools. In Wisconsin there is an arrangement by which normal school graduates may enter the state university in the junior year, thus being put at no disadvantage with students who go directly to the university from the high school. If this policy were made general, I think the matter of teachers for the high schools would be quite satisfactorily adjusted. Scarcely any other arrangements would be needed.

In all our discussion of this subject, we must understand that a large part of the teacher's preparation and the best part of it

must be made while the teacher is engaged in teaching. The teacher who knows it all when he begins is hopeless from the start. He must be imbued with the spirit that thirsts for knowledge, and he must have right views of what constitutes education. Given these, there is hope for almost anyone, no matter from what school he has come, and without them, there is little prospect of anything but the most meager usefulness in the field of education.

Prof. F. E. Lloyd—I have only to say that I agree with the speaker in the main. There is however one point on which I wish to take issue. Prof. Harvey appears to be misinformed in regard to Teachers College, for we are, in that institution, trying to do the very thing he thinks we are not, namely, to prepare teachers in the best possible manner for high school teaching. And we believe that the results already attained justify the claim. We feel that Teachers College can meet the practical demands for the preparation of the high school teacher of the kind who can satisfy the ideals set forth by Prof. Harvey.

Prof. A. J. Grout—I have some personal knowledge of the matter, and wish to second what Prof. Lloyd says. I think he is fairly justified. I only wish however that all the teachers at Teachers College had Prof. Lloyd's judgment in selecting people who can teach.

With reference to the pedagogy of college professors, my experience from personal observation has been that a great amount of poor teaching is in the college. One professor said to me that it was so discouraging to call up man after man, and have him fail, that he preferred to keep on talking.

Prof. C. W. Hargitt—I would like to suggest that our friends can help normal schools in this direction by emphasizing one of the deficiencies of normal school teachers. In our state we have a good many normal schools, and most of them do not give anything like adequate preparation for the teaching of the sciences—one term in botany, one in physics and one in physiology. I have found that the pupils coming to the university from the normal school are not so well prepared in science as

the average pupil coming from the high school. This is a mistake on the part of the normal school, and one which I think is in the power of those having control of the normal school to correct. There are normal teachers here who can confirm what I say. It is a mistake to give teachers the impression that with *one term* in chemistry, they can go out and teach chemistry scientifically.

Prof. Grant Karr—Prof. Karr speaks of high school graduates, and continues: Most of their work is textbook work, and that would give some reason for their lack of preparation. As for college graduates, I have had some of those to deal with in my work as superintendent of a normal practice school. I have had to deal with graduates of different colleges and universities. These young people come to us to get some knowledge of how to teach. Strange as it may seem, they do not get along any better with their practice work in the first few weeks than the average student who has done the regular normal school work. But such students are usually better in the long run.

Some of them seem to have such an abundance of knowledge, and are so deficient in ability to organize such a great flood of knowledge as to be seriously impeded in their work as teachers. One young lady, in particular, a college graduate whom I have in mind, was an entire failure at first, but after 15 weeks got hold of herself, and did much better work. Elementary methods and high school methods are the same essentially, though there may be phases in which they appear to differ very much. College graduates get hold of the practical work of teaching with little less effort than the person who has had less academic preparation. It seems to me that to get the highest development in the prospective teacher, it is necessary for the high school teacher to know something of the teacher's work in the grades. In that way he will come to understand method in its totality, as a principle. A preparation work that takes place in the grades, such as is provided in most normal schools, is a valuable foundation for high school teaching, and could be made use of with profit by high school teachers.

Section C. EARTH SCIENCE

REPORT OF THE COMMITTEE OF SEVEN

PRESENTED BY PROF. RICHARD E. DODGE, TEACHERS COLLEGE, NEW YORK

At the last annual meeting of the New York State Science Teachers Association, the following resolution was adopted:

Moved, that the earth science section of the New York State Science Teachers Association request the president to appoint a committee of seven to consider the preparation of a series of exercises and suggest a course of study for public and high school laboratory and field work, and report at our next annual meeting.

In accordance with that resolution, the following committee was appointed by the president in the late spring and early summer: Richard E. Dodge, chairman, Teachers College, New York; Frank Carney, Ithaca High School; W. W. Clendennin, Wadleigh High School, New York; C. Stuart Gager, New York State Normal College, Albany; P. F. Piper, Central High School, Buffalo; Principal George H. Walden, Rochester; C. F. Wheelock, Head Inspector, Regents office, Albany.

Of this committee, Mr Piper has withdrawn because of illness, and two members have made no detailed suggestions. The report that is herewith submitted contains the opinions of four members only of the committee. Owing to the lateness in appointing the committee, no work could be taken up before Aug. 1. Aug. 8 a letter was sent to each member of the committee as it then existed, asking him to send to the chairman replies to the following questions, previous to Oct. 10, 1901.

1 Shall we organize a course based on the report of the committee of the National Educational Association or on the plan outlined in the *Academic Syllabus* of 1900?

2 Shall we plan a course that will call for a year's work in earth science and hence contain more of the geologic phase of physical geography than the course outlined in syllabus for 1900?

3 Shall we recommend that the course in geology be not included in syllabus for 1905?

4 Shall we plan a course for college entrance and indicate therein the special parts that should be omitted if the course is to be given in the first or second year of the high school, thereby fulfilling a double purpose?

5 Will you kindly take either the course suggested by the committee of the National Educational Association or the course of the syllabus for 1900 as a basis, and indicate what should be included in a course that will, to your mind, best fill the conditions recommended, and your answers to questions 1, 2, 3, 4 and send this to me to Teachers College, Columbia University not later than Oct. 10, 1901? Do not of course consider yourself limited to topics included in these reports; make as many additions or substitutions as you desire.

6 Will you please indicate in your course by check or by some simple means the points that you believe should be illustrated or amplified by laboratory or field exercises? This will give us a basis for organizing the exercises later.

Owing to the small amount of time available for committee work, the committee has decided to present merely a course of study this year. The chairman has had in mind not only the question of presenting a practical course of study in geography for high schools, but also a course of study which should improve on the present requirements of the Regents, and at the same time meet the requirements in physical geography as outlined by the College Entrance Examination Board of the Middle States and Maryland, requirements which are herewith presented as a basis of consideration.

Physical geography

The requirement in physical geography is based on the report of the committee on physical geography of the science department of the National Educational Association.

The following outline includes only the most essential facts and principles of physical geography, which must be studied in the classroom and laboratory. The material is for the most part common to the leading textbooks, though it should be recognized that no adequate laboratory manual is at present available. The order of presentation is not essential; it is recommended, however, that the topics be treated in general in the order given.

Outline

Recognizing that the field of physical geography in secondary schools should include (*a*) the earth as a globe, (*b*) the ocean, (*c*) the atmosphere, and (*d*) the land, the following outline is

planned to cover these several large topics, with the further recommendation that the time allowance be proportionally increased in the order named.

EARTH AS A GLOBE

Shape of earth, how proved, consequences of shape
Size. How earth is measured; effects of size
Rotation: character of motion; latitude, longitude, and time
Revolution: rate, path and direction
Magnetism: compass, poles, variation
Map projection

OCEAN

Form, divisions, and general characteristics of the ocean
Depth, density, temperature of ocean waters
Characteristics of ocean floor
Distribution of life in oceans
Movement of ocean waters
  Waves—cause and effect
  Currents—causes, proofs of causes, important currents, effect of currents
  Tides—character of motion, cause of tides, variation of tides, bores
Work of ocean
  Classes of shore lines and importance of shore lines

ATMOSPHERE

Composition and offices of atmosphere
Instruments used in study of atmosphere
Temperature
  Source and variation of atmospheric temperatures
  Isothermal charts of world, January and July, with special study of isotherms of northern and southern hemispheres, of location of heat equator, of cold pole, of crowded isotherms, etc.
Pressure
  Measurement of pressure
  Use of pressure in altitude determinations

- Relation to temperature
- Study of isobars on United States weather map
- Distribution of pressure over world in January and July
- Relation of isobars to isotherms

Circulation of atmosphere

- Winds, classes, directions, causes, effects

Moisture

- Source, forms of, measurement of, precipitation

Storms

- Paths and characters of storms of eastern United States
- Daily weather at different seasons
- Relation of storms to general weather conditions
- Relation of weather to climate

LAND

General features of land as compared with ocean

Distribution of land

Map representation of topography

Changes in land forms, effects of elevation and depression

Plains

- Kinds of plains
- Characteristics of different kinds
- Development of plains
- Coastal plain of eastern United States in parts
- Alluvial plains, their formation and importance
- Relation of life conditions to different forms of plains

Plateaus

- Young plateaus
- Dissected plateaus
- Old plateaus
- Broken plateaus

Mountains

- Block mountains
- Folded mountains
- Domed mountains
- Massive mountains

Volcanos

- Distribution
- Character of at different stages

Rivers

Life history of river—work of rivers, topography of valleys at different stages; lakes and lake basins

Revived rivers

Drowned valleys

The great drainage basins of the United States

Glaciers

Existing ice sheets

Kinds of glaciers

Work of glaciers

Characteristics of glaciated area of northern United States

SUMMARY

Relation of man, plants, and animals, to climate, land forms, and oceanic areas

The outline given can but present the larger topics to be covered, and in a way suggest the point of view desired. Each topic should be treated so as to show its causal relations to other topics, and so far as possible the effects of earth features on life conditions should be emphasized.

The candidate's preparation should include: (1) The study of one of the leading secondary textbooks in physical geography, that a knowledge may be gained of the essential principles, and of well selected facts illustrating those principles. (2) Individual laboratory work comprising at least 40 exercises selected from a list not very different from the one given below. From one third to one half of the candidate's classroom work should be devoted to laboratory exercises. In the autumn and spring field trips should take the place of laboratory exercises.

List of possible exercises

Numbers in parenthesis indicate the value that should be given in estimating the total number of 40.

WORLD AS A GLOBE

Construct a diagram showing inclination of earth's axis, and effects of an axis at right angles, and parallel to plane of orbit (1)

Cause of day and night, and extent of sunlight over surface (1)

Construct a diagram showing position of earth, moon, sun, at the several phases of moon (1)

Construct a series of lines to one adopted scale, showing circumference and diameter of earth, and distance of several leading large cities from New York (1)

Determination of latitude, north and south line and high noon (1)

OCEAN

Study of ocean current maps (1)

Study of tide charts (1)

Study of types of shore lines (2)

Study of position of lighthouses, life-saving stations, and large cities in relation to southern Atlantic shore (1)

Study of map of world showing hights of land and depth of sea (1)

Explain selected steamer routes across Atlantic and Pacific (1)

ATMOSPHERE

Determination of altitude of hill by barometer (1)

Determination of dew point (1)

Comparison of January and July temperatures at 40° n. and s. lat. (2)

Location and migration of heat equator and cold pole (2)

Comparison of temperature over land and water at different seasons (2)

Study distribution of wind systems by seasons, and compare with pressure conditions (2)

Make isotherm and isobar maps from furnished data (2)

Find average wind directions about a storm center (1)

Making of complete weather maps from furnished data (2)

Study distribution of cloudiness and rainfall about a storm center (1)

Predict weather conditions from data furnished (1)

Find average rate and direction of motion of storm centers (1)

Study of condition of "cold waves" and "northeasters" (1)

Rivers

- Life history of river—work of rivers, topography of valleys at different stages; lakes and lake basins
- Revived rivers
- Drowned valleys
- The great drainage basins of the United States

Glaciers

- Existing ice sheets
- Kinds of glaciers
- Work of glaciers
- Characteristics of glaciated area of northern United States

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Location and migration of heat equator and cold pole (2)

Comparison of temperature over land and water at different seasons (2)

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Make isotherm and isobar maps from furnished data (2)

Find average wind directions about a storm center (1)

Making of complete weather maps from furnished data (2)

Study distribution of cloudiness and rainfall about a storm center (1)

Predict weather conditions from data furnished (1)

Find average rate and direction of motion of storm centers (1)

Study of condition of "cold waves" and "northeasters" (1)

LAND

Comparison of areas to scale (1)
Making cross-sections of contour maps to scale (4)
Cross-section of hachure map and changing hachure to contour map (2)
Writing description of models (4)
Writing description of pictures and accompanying map (2)
Construction of river profile (1)
Making drainage map of United States (1)
Written description of selected maps illustrating classes of land forms (4)
Planning a journey and describing country to be seen (1)
Locating illustrations of common land forms on some special contour map (1)
Four excursions in autumn, described in detail (8)
Four excursions in spring, described in detail (8)

At the time of the examination the candidate must present the original notebook in which he recorded with dates the steps and results of his laboratory exercises. This book, which should contain an index of subjects, must bear the indorsement of the teacher, certifying that the notes are a true record of the pupil's work. This notebook will be returned on request at any time within a year.

The committee has taken as its basis of work the recommendations of the subcommittee on physical geography of the committee on college entrance requirements of the National Educational Association. Three out of four of the members answering the questions proposed agree in recommending this report as a basis for our work; one member believes that the plan outlined in the *Academic Syllabus* for 1900 is superior in that it contains more than is proposed by the National Educational Association committee. The other members of the committee answering believe that the Regents report contains many unrelated and unnecessary facts, that it is less logical than it ought to be, and that we should plan a course "more prescriptive and

yet giving freedom to the individual teacher." Three members of the committee believe that we should present a course of physical geography covering a year, and that geology should be dropped from the *Academic Syllabus* of 1905. This seems in line with the best thought in reference to secondary work as it now exists in the country. Three members of the committee believe that the colleges should accept for entrance a good course planned for the first or second year of high school work.

In accordance with these recommendations the following course of study has been worked out by the committee. This is a compromise course covering the accepted fields of physical geography, but there is a difference of opinion in the committee as to the order in which the larger topics should be considered. One member of the committee puts the ocean immediately after the earth as a globe; two members put the atmosphere in this position; and one recommends the ocean after the land.

It is understood, of course, that this plan as presented is merely an attempt to order the important related geographic topics pertinent to a secondary school course in a logical way, so as to produce under good teaching the best mental training on the part of the pupils. It is believed by the committee that mental training is more important than information as a result to be gained from geography work.

The course as outlined herewith should be presented in its larger topics, whether that presentation be in the first or last years of the high school course; but many details herewith included must be omitted if the course is carried on in the first year. Several members of the committee have recommended a special course on the physical divisions of the United States, or the physiography of New York state, as an elective in the advanced years of the high school, if the course presented here be given in the elementary years. The committee as a whole, however, makes no recommendations on this matter.

If the course outlined is adopted, and if the section desires to have recommendations later presented in reference to laboratory work, the committee should be continued.

Physical geography

Course of study for the high school

The earth as a globe

Topics marked * should not be included in a first year course.

The shape of the earth

*Historical. Eudoxus

*Problem. If the north and south line of the surface of the earth were represented in profile by either of the following lines, how would the aspect of the sky be affected in each case by moving along the line? 1——; 2 ⌣; 3 ∧; 4 ⌢.

*Aristotle. The earth a *small* globe

*Strabo (beginning of the Christian era), first gave the argument from the appearance of ships at sea

Simple proofs of shape of earth

Results from living on a globular gravitating earth

The size of the earth

*Eratosthenes and the well at Assouan (Syene)

*The caliphs (11 cent. A.D.), Cassini in France (late 1600 or early 1700), Newton, Richer, French Academy (1675)

Effects of size of the earth on human life

Motions

Rotation

How known

Character of the movement

Consequences of rotation—defining direction, determining relative position, measurement of time, day and night, flattening at poles

Life effects due to rotation. Application of shape and rotation to

Latitude and longitude

Origin of the terms

Necessity for parallels and meridians

Longitude

*First determined by Strabo. How? Chronometer method and telegraph

Determination of a north and south line
Latitude
Determination of local latitude by the sun circle method, and by the altitude of the sun as determined by a north and south line
Use of latitude in navigation
Application of latitude and longitude to
*Maps and map projections
Need of maps. Meaning of the term map
How maps are projected
Orthographic, conic, Mercator projections
Revolution
Rate, path and direction of revolution
Construction by pupil, from given data, of the exact shape of the earth's orbit. Seasonal distribution of energy
*The earth as a magnet
The compass
Determination of local magnetic meridian and angle of variation
Isogonal lines
How the life of man is affected by living on a magnetic earth

The atmosphere

An invisible gas
Composition
Gases. Dust. Relation of different components to plants and animals, including man. Relation of atmosphere as a whole to the life of man
Introduction of summary of weather and climate elements, as illustrated by selected days
Directions for taking weather observations, and explanation of instruments used
Temperature
Source of atmospheric temperature. The nature of heat; how measured
Thermometers—centigrade, Fahrenheit, maximum, minimum

Relation between angle at which rays strike and their intensity. Diurnal changes of temperature

Distribution of heat—vertical, horizontal; need of graphic representation of temperature distribution. Isotherms. Study and explanation of isothermal maps of January and July and annual average of northern and southern hemispheres

The heat equator. Its migration north and south, causing

The change of seasons—explanation with individual apparatus

Crowded isotherms and their explanation

Relation of life to seasonal and diurnal temperatures

Atmospheric pressure

Introductory—demonstration and measurement of pressure

Method employed—aneroid and mercurial barometers—barometric readings—*when taken—*reduction to sea level

Determination of altitude by means of barometric pressure

Expression of pressures by isobaric lines. Seasonal isobaric conditions

Relation of pressure to temperature

(In first year work no such detailed classification should be attempted. A description of the general system of winds and a study of the relation to temperature and pressure conditions is essential, however)

Winds. What is a wind? Direction of motion

Methods of observation, measurement of velocity, classification according to velocity, etc.

Winds consequent on a rotating planet (planetary)

Trades; prevailing westerlies; doldrums; horse latitudes; upper currents. Relation of wind belts to isobars and isotherms

Location and characteristics of each belt

Winds consequent on a planet inclined $23\frac{1}{2}°$ on its axis (terrestrial)

Seasonal changes. Shifting of calm belts—consequent disturbance of path of winds—effect of earth rotation

Seasons and character of life in each area

Winds consequent on distribution of land and water (continental)

Continental winds

Monsoons

Winds consequent on diurnal conditions

Land and sea breezes

Mountain and valley breezes

Humidity

Moisture as it exists in the air—*how measured

Origin of atmospheric moisture. Evaporation

Humidity—absolute, relative. Relation of temperature to absolute humidity

*Hygrometry. Condensation, dew point, saturation

Precipitation. Dew, fog, cloud, frost, hail, snow, and rain—how recorded in amount. Study of rainfall chart of the world

Relation of rainfall to interests of man

Agriculture (discuss value of irrigation)

Forestry

Manufactures

Commerce

Storms of the westerly wind areas

Control of the weather by storms

Characteristics as to temperature, pressure, winds, cloudiness, rainfall

Path and rate of progress

Hot and cold waves, northers, blizzards, etc.

Study of weather maps[1]

Local observation begun at the commencement of the work on the atmosphere. Weather predictions. Weather Bureau instruments, economic aspect

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[1]This topic should be made brief in first year classes.

Summary of weather and climate

Weather

Characteristic summer and winter weather of eastern United States

Study weather signals employed by United States government

Climate

Relation of weather to climate. Most important climatic elements

Climates of the different heat belts

Subdivisions according to varying character of different portions—land and water, coasts and interiors, mountain and plateau

*Dominant climatic features of these subdivisions

*Seasonal conditions; effect on life

General relation of climate to vegetation, animals, man

The ocean

Distribution of land and water

To be studied from a globe. Land and water hemispheres—London as a center of land hemisphere

Physical characteristics of ocean water

Density. *Causes of variation in density. *Color and phosphorescence. Temperature. Greatest variations—where found. *(Study of charts and diagrams, showing distribution of ocean temperatures, with causes and consequences of observed facts)

*Character of the bottom. Comparison with land conditions

Ooze—Globigerina (Foraminifera)

Absence of weathering on ocean floor, and its results

Depth—average—where greatest

*Divisions of oceanic areas

Great oceans; depth and volume compared with extent and elevation of land surface

Mediterraneans—relation of important ones to continental masses

Significance of temperature peculiarities

Submerged continental shelves—relation to continental masses

*Ocean life

Very varied. Shallow water and deep water life, and their comparison

Movements of ocean water

Easy—slight friction

Waves—Cause. Wave motion; *definition of wave parts—crest, trough, front, back, hight, length, velocity, period; limit of wave hight; use of oil at sea; effect on waves of shoaling; undertow, surf, breakers; how waves strike the shore; focusing at headlands

Currents—how known to exist; description, location, classification (warm, cold), deflection by continents and by rotation of the earth. Cause—*inadequacy of convection theory; comparison of charts of ocean currents. *Hypothesis that winds are the cause; *testing the hypothesis that winds are the cause. Important currents, oceanic eddies; economic importance of currents

Tides.[1] Description of tidal phenomena as observed along shore; comparison of tidal phenomena with phenomena of waves; comparison of tidal periods with lunar periods; explanation of tide-producing forces with diagram; testing hypothesis that tides are caused by the moon; spring and neap tides, bores, tidal races; economic aspect of the tides

The land

General features of the land compared with those of the ocean

The materials of the earth's crust

Mantle rock; bed rocks; the more common rocks and their general characters; stratification and its explanation

Weathering—origin of soils

Evidences and agencies of weathering

Results—formation of soil, widening of valleys

Strong rocks, or ridge and highland makers

[1]This topic should be treated briefly only in a first year course.

Weak rocks, or valley and lowland makers
Crystalline rocks, and their effects on topography
Stratified rocks, and their effects on topography, as determined by their relative strength

The work of the wind
Blows dust and sand—beaches elevated, loess, sand dunes; erosive action—ledges attacked, faceted pebbles; importance—enriches soil by distributing it; wind action checked by vegetation and moist climate

The work of water on the land
Fallen rain
Evaporates; sinks into the ground; runs over the surface, resulting in erosion; definition of a river, river system, basin, divide, watershed
The erosive work of a stream. Relation between transporting power and velocity
Results of erosion. Evidences that most rivers have carved their own valleys
Formation of tributaries by the gnawing headward of gulches
Young, mature, old, river valleys. Characteristics of each. Base level of erosion
*Migration of divides. Economic importance of this. Stream capture and beheaded rivers
Drainage systems of home locality, New York state, United States, world. Interior drainage basins
At first the topography guides the course of the streams, later the streams determine the topography
Impediments to the work of rivers
The work of a stream is impeded when its velocity is checked
At maturer portions due to base leveling
By the ocean and lakes
Results of impeding the velocity of streams
Deposit of sediment in the bed of the stream along the banks (flood plains), at the mouth—Study of cross-sec-

tions through flood plains. Economic importance, e. g. lower Mississippi jetties

Deposits at mouth of streams—Alluvial fans, deltas, continental shelf. Conditions of their formation. Results. Length of stream not constant

Effects of depression of rivers. Drowned valleys

LAKES

Relation of lakes to rivers. Distribution of lakes in United States. How made

Lakes in glaciated regions. Oxbows and cut-offs in alluvial plains

Lakes in arid regions. Bonneville, Lahontan

Lakes in volcanic regions

Lakes contrasted with waterfalls and rapids. Ultimate destiny of lakes

GLACIERS

Characteristics of glaciers

Snow field, névé, ice stream

Resemblance to rivers

General characteristics and distribution of existing valley, piedmont, and continental glaciers

Work of glaciers

Erosion, scouring, and scratching; transportation and deposition—moraines, lateral, medial, ground, terminal. Other deposits—drumlins, eskers, kames, overwash plains, valley trains

Ancient glaciers—the ice age in America (North)

Effect on topography and drainage

*The Laurentian lakes and Niagara. *The "Finger lakes" of New York state

UNDERGROUND WATER

Springs—conditions of their formation

Kinds, special mention of—artesian wells, hot springs, geysers

Solvent power of underground water. Limestone caves

*Reasoning from the phenomena of hot springs and geysers, what is the temperature condition of the interior of the

earth, leading to other evidences of internal heat as found in the study of

CLASSIFICATION OF LAND FORMS

Necessity of expressing land features by maps. Interpretation of maps

Maps showing

- Relief, shading, hachure, contour lines
- Comparison of contour maps with pictures of the same locality (or with direct observation, if of the home locality). Written descriptions of topography from map reading
- Drawing of cross-section profiles to scale from contour relief maps
- Field work in mapping and in cross-section drawing

Plains

- Of construction
  - Coastal plains: characteristics, structure, origin. Early shore line and subsequent modifications. Drainage and dissection. Water supply. Fall line—how formed. Influence on human occupation and activities. Stages in development: youth, maturity, old age
    - *The geographic cycle
  - *Classification of coastal plains: narrow, broad. Examples of each. *(Ancient coastal plains: New York, Wisconsin, England)
    - Geographic controls on coastal plains
  - Effects of coastal plains. Examples

Effects of earth movements on position of rocks

- Dip, strike, folds, tilts, etc.

Mountains

- Essential idea of mountains. Brief suggestion of causes of mountain building
- Block. Young stage, e. g. northern California and Nevada. Characteristics; how formed, drainage, and dissection Earthquakes and their significance here. Effects on distribution of life

*Dissected block mountains, e. g. Utah
Characteristics. Effects of dissection; climate; control of human occupation and life
Folded mountains, e. g. Juras, Appalachians
Characteristics; topography. Drainage and its modifications
Stream capture
*Domed mountains, e. g. Black hills
Treated as block, dissected block, and folded mountains
Plateaus
Young, e. g. Shiwits
Compared with plains of construction as to surface, structure, elevation, drainage. Effect on man
Dissected, e. g. Catskill, Alleghany, Cumberland
Old, e. g. New Mexico
Mesas, buttes. Ancient civilizations of North American aborigines
*Broken. Character, drainage, relation to man
Volcanos
Definition of volcano. Relation to the life of man and to the lower organisms. Features of young and old volcanos
Description, distribution, causes. Mapping of volcanic regions
Earthquakes
Description. Regions of greatest frequency. How observed; causes; relation to man
Plains of destruction
Characteristics, specially as seen in southern New England
Contrast with construction (young) plains
Terms—pene-plain, monadnocks
Relation of plains of destruction to other land forms
Effect of uplift. How old plains differ
Drainage—comparison with that of young plains
Culture relations; effect of change of base level
Shore lines
Meaning of terms shore line and coast

On what does original outline of coast land depend?
Classification of shore lines
Number of classes—how produced; characteristics
Elevated shore lines
Characteristics
Changes effected by the ocean
Sand reefs—formation; advance and retreat; deltas and bays
Inlets—relation to coastwise traffic; tidal deltas
*Effects of depression and elevation on this class of shore lines
Effect on man; distribution
Depressed or drowned shore lines
General characteristics; relation to man's life
Changes effected by the ocean
Formation of sea cliffs and benches; sea caves
Formation of bay head beaches and retreat of sea cliffs; *formation of barrier beaches and general retreat of shore line—*effect of strong tides
Land-tied islands—process; importance to man

Summary and conclusion[1]

The relation of all life, specially that of man, to geographic environment. Adaptation to changes in environment. Gradual mastery of environment by man with the advance of civilization. Importance of geographic control as shown by historical and commercial facts.

THE EARTH AND MAN

Summary and review

Civilization as related to environment
Environment exercises strong control over barbaric races. Examples
Civilized peoples
Control of the past

[1]In a first year class it is recommended that the summary of the course be merely a review of the principal points in life geography that have been touched on in the progress of the work.

Control of the present—less marked. Ability to overcome existing conditions

Traveling across the continent today compared with difficulties encountered half a century ago

Relation of surface features to man

Mountains—barriers due to trend, steep slopes, lack of water, rarity of air

Effect of barriers on the settlement of a country, e. g. influence of the Appalachian barrier on the settlement of the United States

Determined lines of settlement

Directed and limited immigration and migration

Strengthened early settlements

Offered protection from enemies

Dangers arising from a sharp line of demarcation between a people

Comparison of natural and political boundaries

Relation of pioneer settlements of Mississippi valley and Atlantic states

Effect of barriers on the development of a region

Growth checked through limitation of boundaries. Newburg and Fishkill compared

Effect of mountains on life of people

Characteristics of mountain dwellers—Scotch, Swiss, etc.

Differences in a people arising from separation of valleys, e. g. clans of Scotland

Slow development of isolated mountain dwellers. Mode of life of the natives of the mountains of Tennessee and Kentucky

Influence of mountains on industry

Valleys

Gateways for exploration

Regions of early settlement. Compare the settlement of the Mohawk and the Hudson valleys with that of adjacent mountains and plateaus

Importance commercially, e. g. Hudson and Mohawk valleys a great factor in determining the supremacy of New York city
Highways of travel
Plains
Seat of early civilization, e. g. Chinese—developed in river plains of China. Hindus, in plain of Ganges
People of great plains—tendency toward a nomadic life. American Indians, Arabs of the eastern deserts
Influence on settlement. Uplands and lowlands of New England compared
Influence on industry
Seashores
Regular—lack of harbors unfavorable to development of great nations
Irregular—favorable to growth of nations, e. g. Greece and Rome
Great nations of today
Influence of seashores on industry
Relation of climate to man
Effects of extreme heat, of extreme cold on man's mental and physical activity, e. g. dwarfs of the African forests, Eskimos of Greenland
Effects of a temperate climate on man. Heat belts in which the great nations of the world are found
Dry climate—importance of control directly on vegetal life, indirectly on animal life and man
Industries of semiarid plains and plateaus
Industries of well watered regions of gentle slopes
Rainfall east and west of 100th meridian w. longitude noted—effect on industry
Industries of regions of extreme cold—of tropical regions
Relation of economic products to man
Effect on migrations. Discovery of gold in California, in Australia. Influence on industry

Influence of man on the earth

Modification of environment. Land reclaimed from the sea—dikes built, streams diverted, hills leveled, marshes drained, deserts made fertile, etc.

Distribution of plants and animals influenced

Destruction and limitation of plant and animal life, e. g. buffalos, seals; forests—effect of destruction of forests

Distribution of plants and animals extended

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[The discussion was led by Head Inspector C. F. Wheelock, of the Regents office, who emphasized the necessity of having a course sufficiently elastic to allow the local environment to be used by any teacher, and further one that would allow each teacher to make special use of the facts and methods most familiar to him.]

Miss Elizabeth E. Meserve—I hesitate to criticize the combined mental work of seven men. Nevertheless, I shall speak from the standpoint of a teacher in the secondary schools and teacher of physical geography. For whatever these men may decide on as a suitable collection of facts for a course, the work of teaching this will probably fall to a woman.

First, in regard to the suggestion that physical geography be made a full year's course. If this course is to come in the first or

second year of the high school, I say *no.* I object to teaching physical geography in the first year as the course *now* stands. I believe that much of the so called physical geography can be taught in the grammar schools in connection with the course in geography, reserving the more difficult part not for the high school, but for college. The pupil comes up to the subject of physical geography, as the course is now planned, with no science to help him, and he has what should be a review of many of the sciences before he has had the subjects themselves. I am not in favor of offering physical geography as a college entrance subject. The pupil, in my mind, will receive more mental training from some definite branch of science. When we teach physical geography in the first year, we are hampered in the very beginning of our work. In order to understand the motions of the earth and their relations to the physical conditions on the earth, the atmosphere and the movement of the ocean waters, some knowledge of the principles of physics is needed. To understand the earth's crust, its structure and the resulting forms, the pupil needs some knowledge of geology. So much of our time is spent and must be spent in teaching some of these principles that we almost forget just what we are supposed to be teaching. And it leaves so little time for the relations which exist between the earth and the life on the earth, that these things come in, in many cases, like the moral to a story.

Our work is too fragmentary; we touch on too many things. In botany, zoology, physics, or chemistry, we bring the pupil to some place where he has the feeling of something definitely accomplished.

The course as submitted by the committee of seven differs from the Regents course in leaving out some of the unrelated matter, or very distantly related matter. This also enters more into details, too much so, perhaps, in the subject of the land.

As to the order of subjects, it seems to me a minor matter, as teachers must adapt that to the time of year in which the subject is taken up. Under the subject, "the earth as a globe," as outlined in this course, I believe we should omit the histori-

cal references, referring to them in a very general way, but making no definite study of them. The pupil in the first year has but little knowledge of history, and names of famous astronomers and physicists mean nothing to him; neither do dates appeal to him as interesting topics. Then, too, for the best understanding of these problems, more knowledge of mathematics is necessary.

I believe we should emphasize rather more the importance of the subject of latitude and longitude, the location of places, the differences in time, and the uses of latitude and longitude in navigation and surveying.

The facts in regard to maps I should leave till later, unless I forget it altogether. Logically, of course, it comes in at this place in the outline. But practically it will be much better understood much later in the subject. After the pupil has done some field work, and made careful plottings in his notebook of local places, indicating position of lakes, forest regions, hills or mountains, and traced the course of one or more rivers (for a part of its journey); after he has done all this, the use of maps will be quite clear to him, and relief, shading, hachure and contour lines will stand for something more than vague terms. I am not sure that it matters whether he ever knows just how the Mercator or orthographic projections are made. He will know the practical value of a map, and can interpret it intelligently.

We are inclined, in plans for physical geography, to place too much stress on the subject, "the earth a magnet." We expect the pupil to understand all about magnets, and to apply that knowledge hastily gained, to the consideration of the earth as a huge natural magnet. We expect him to talk intelligently about the magnetic needle, its variations and its use in the compass. At this point the Regents call for a certain ability to name "electrical phenomena." I am glad that this is omitted in the outline. The word phenomena carries a great deal of fear with it any way, and, when you prefix to that "electrical," with all the strange misunderstood and non-understood qualities of electricity, the pupil is overwhelmed with the awfulness

of the things he has to remember, and he associates, instead of our beautiful aurora borealis, electrocution as an electrical phenomenon.

Under the topic, "physics of the atmosphere", comes a great difficulty. We forget that we have made the jump from magnetism to heat and pressure. The principle of the thermometer and barometer must be mastered. The isotherms and isobars must be fully understood. Very little can be done with the subject, "light", as the average pupil can not understand, at this stage of his mental development, the principles of refraction and reflection. Winds, humidity, storms and the weather charts, supplemented by actual observations on the part of the pupil, require a large proportion of time.

Under climate, considerable time must be spent on causes. It is quite necessary that the pupil be able, not only to state the width of the different zones, but to tell why they are of such width.

If we ask pupils to tell about "the midnight sun", we receive strange information. Is that to be wondered at when grown people remain confused? A man, in giving a stereopticon lecture to children of the grammar grade, made this statement. He had shown a picture of "the land of the midnight sun"; "And now, children", he said, "the peculiar thing is this: the sun does not rise in the east and set in the west, but it comes up anywhere and goes down anywhere."

At first I thought that the outline was altogether too long on "the ocean"; but I soon discovered that at least one third of the outline is what we usually class under the topic, "the land". This leaves the description of the ocean bed, something of the temperature of the ocean waters, and the life in these waters, as minor subjects, to be treated briefly. Some time should be spent on the subject of currents, but *tides* the pupil can hardly comprehend.

Of course the main work in physical geography is that which comes under the topic, "the land". This we want to make as complete as possible, and yet keep out as many technical terms

as we can. I hope a course in physical geography may be prepared which will combine the simplest facts—perhaps better, the most closely related facts of the earth, its influence on plants and animals, and man's relation to the physical conditions of the earth, and his part in the distribution and destruction of animal and plant life.

[The third speaker was Prof. Albert P. Brigham, of Colgate University, who spoke from the standpoint of the college. Prof. Brigham proposed some minor changes in the text, and spoke in reference to the preferred order of the larger topics. He emphasized further the necessity of having one year's continued work in physical geography, if the work is to give training proportionate in value to that given in the more exact sciences.

Under the five minute rule the report was further discussed by W. W. Clendennin, of the Wadleigh High School, New York, by Frank Carney, of the Ithaca High School, and by Prin. George H. Walden, Rochester.

At the conclusion of the discussion the section voted to ask the association to continue the committee of seven one year, to draw up a series of laboratory exercises in physical geography, to accompany the report of this year, and to outline a course in geography for elementary schools.]

Section D. NATURE STUDY

Prof. C. R. Drum—I feel a little out of place opening the subject this morning. I know very little about nature study. I have tried to do a little work along that line in the vacation schools of Syracuse. We had five last year. On the average we took four or five hundred pupils into the country every week. I always accompanied the teachers on the trips.

I ought to speak just a word about the class of pupils. They are pupils from the congested districts, the crowded districts, from what we might call the lower strata of society largely. Of course not all; they are newspaper boys, etc. Last year we did nature work for boys, this year, for both. I intended to prepare a definite, concise paper, but my little boy was sick

and I was unable to do it; so I shall have to give you four or five little illustrations from our work. First, I want to speak of the garden at Fraser school. As soon as the Board of Education decided to have a summer school at Fraser, the teacher who was appointed to have charge of that school immediately began to put in a little garden over there. The children were interested in the garden. People said it was no use, "because, if you do, the bad boys in the neighborhood will destroy it." It is a fact that the garden never was touched. One of the most troublesome boys in the school went one time and planted a little vine in that garden when there wasn't anyone around. And do you know those fellows protected that garden? No one would think of going into that garden. I assert that there is a certain amount of moral training there that ought to be duplicated everywhere.

In another school a boy brought down a big, green caterpillar. He brought it down to have me see it. I did not get down to that school that day. He had it in a box. He kept it over night. In the morning, the next day, when I arrived, he brought out his box to show me the green caterpillar; and during the night that green caterpillar had begun to weave his cocoon, and had it partly woven. It was thin all over the body, and a more surprised boy you never saw in your life than that little fellow. I imagine that boy will pick up all the green caterpillars he can find forever after. I think he has the cocoon. That boy will some day be a scientist, I judge, because of his interest, and will create an interest for those things in the other boys with whom he comes in contact. That boy will be a scientific investigator. There is no question about it. He is so interested in it. He might have read that in the book, but it would not have had the same interest as to get the knowledge firsthand.

There is another illustration which I wanted to bring up. A group of boys from the summer schools begun last summer, were looking intently at an object on the ground. They were apparently very much interested in something. A teacher in a school,

passing, saw them. She approached the crowd and inquired of one of the boys, "What are you looking at?" He says, "Looking at a toad down there." He said that Mr Smith told them the story of the toad, all about the toad, many interesting things about it, and told them the next time they saw one to watch it. Now, good seed always bears fruit. The teacher who told the story of the toad little thought of the interest he had created in one of God's most humble creatures. Ordinarily those boys would have kicked the toad off the sidewalk or hit it. That is moral, ethical training, and those boys are becoming investigators, and some day some one may be a scientist. They are getting the spirit of investigation in this nature study work.

We took trips to the Valley, up into the Glen, and on one of the trips I went up into the Glen ahead of the boys. They were interested in the appletrees which no one in particular owned, and they would climb the trees and help themselves to the apples; and I stepped up into the Glen. I saw a chipmunk on the sidehill, and I sped back as quietly as I could and told the boys I wanted them to see and come quietly. You have read Cooper's description of the Indians when they were after anything, how they would go. I imagine those boys got up into the Glen something like that. A large number of them had never seen a chipmunk, and the interest, pleasure and profit they got from watching that little fellow seemed to me wonderful. I felt that not a boy there would ever take an air gun and shoot a chipmunk. I used to when I was a boy; liked to shoot red squirrels and chipmunks, etc. No one taught me any better.

Those lessons give to the children a desire to love all of God's creatures; and you must appreciate the fact that these boys are the boys of our streets. A little farther up the Glen a group of girls were watching something on the rock, and, when I arrived there, they were interested in a snail. I believe in our trips; on the trips we collected a great deal of material. We did not have anything but what we would use in the next week's work. Each school had a trip one day in the week. They were watching that snail and were much interested in everything they

could see. I never had so many questions asked me before in the world, and so many I could not answer. I had to say we would endeavor to find out. The interest in nature of those little fellows was marvelous. The chance of a snail with the house on his back, crawling along, to teach a lesson of God's care of His creatures!

Nature study not only teaches children to observe and investigate, but it turns their minds to the moral side, and also to the ethical and to the religious, if I may say so. It seems to me it is one of the most fundamental subjects we have to deal with.

After the vacation schools closed, I went down to Otisco lake fishing. I was seated in the boat fishing, and hooked on a crab. It would squirm a good deal; I threw it into the water over there, and by and by got hold of a bass. Do you know that during the first part of the trip I enjoyed that immensely, but somewhere from my subconscious self there loomed up something, an impression, and I said, "My pleasure is the suffering of that poor bass over there." I was fishing for fun, not because I wanted something to eat. The impression came to me that that was wicked. Where did I get it? From my nature study trips with the boys. In trying to help them, something seemed to react on me. I declare, I went down for a two days' fishing trip: I stopped fishing and went in, and went home. Perhaps it was foolish and perhaps wrong, but I felt that way. I have not been fishing since. I may go again sometime; but that is the way I felt that day. Men will go up into the woods and shoot the deer. Boys brought up to nature study won't do it. To get a fine photograph of one is better than to do that.

We took from 50 to 150 children on the trolley. Usually had three or four teachers. They were very well behaved. This summer they paid their own fares. Last year I paid all the fares. Perhaps it is just as well to have them pay the fares. Oh! how they enjoy it! It gives them such a fund of material. If they went out without direction, nothing would be applied, but direction of attention is necessary. We had no particular

object in view except to get out. We simply, if we ran across anything like the snail or chipmunk, observed it; or, if we found something to bring home, we brought it. We played games after we had the little trip, half or three quarters of an hour.

Cornell University sent some excellent help down year before last. They gave me most of my ideas on nature study work. Mrs Comstock, Miss McCloskey and others.

I had been over the ground a good many times. The teachers had to answer the questions, "What's this?" "What does it mean?" "What is it good for?" "What does that do to you?" I never felt my ignorance so much in all the world as I felt on the trips. I was perfectly frank. I did not assume to know what I did not know.

The boys who went the first year became leaders the second year, and they know a whole lot of things. I have in mind one boy in particular who developed quite an interest from the previous year. He was delighted, too, to be one of the leaders. He had a little crowd, and could tell them many things, which was due to the fact that they get a little material each time, and that was added to.

I had no previous training. A little zoology out of a textbook at normal school; and I had studied geology some—that is all. The only thing is to begin, and you learn a lot. I have learned quite a little. I have been obliged to. A child brought a beautiful moth over to my house. I have been looking it up and finding out its history. There is a great deal of enjoyment and satisfaction in it.

John W. Spencer—Yesterday afternoon the discussion ran on the minimum amount of scientific knowledge a teacher should have in order to have a license to teach nature. This morning we are trying to bring up evidence that a person without any knowledge and with a love of nature can teach something. The main thing is to have a handle on what little we do know, so we can bring it out. As I said, Mrs Miller anticipated that point. I was going to ask about it.

Prof. Drum—I intend to be able to pass the examination later.

John W. Spencer—Then, Prof. Drum, you believe that one of the important features is to inspire the children as to new reasons?

Prof. Drum—Yes. If you can start them off and keep them moving they will get enough to keep them going all their lives. I gave those illustrations with the thought that those boys will continue in that line.

John W. Spencer—In your boys you have excited wonder and interest; and, whatever they saw, they felt as if it had meaning and wanted to know the meaning? That is your method?

Prof. Drum—Yes.

Mrs Miller—Miss Whittaker, of Brookton, has had some experience with carrying on clubs of nature study; clubs for children. I have asked her to tell us something about the club, how it began, how it continued, and what she feels has come of it.

Miss Elizabeth Whittaker—To begin with, I feel that I have not done any nature study work. I never heard of nature study till November 1900, when I received a circular letter from the university and the directions for the organization of clubs. I had been fond of the study of nature; and, when I began teaching in September, I went out with the children two or three times each week into the country. Nearly all geography work was done through these excursions or walks. The leaflets were a valuable aid; and, in case I became puzzled, I would write to Mr Spencer to find what next to investigate to understand clearly the matter in hand, or what book would give the desired information. The idea came that perhaps I could make a club serve to discipline the room, a sort of self-government scheme. I asked the children one night to stay after half-past 3 and talk about organizing a club for the study of common things and the taking of regular walks. I told them I thought it would be a good idea to start with few people. I decided to take 12, a certain number from each grade, chosen from those having the highest standings. The best work counted most. I told them that each morning for 10 minutes we would talk about interesting common things. They might bring anything

to school they liked. Any one might speak. All had the full privilege just as much as the members. I used the 10 minute talks to prevent tardiness. There were 73 cases the year before, which I did not like. I told them that the club members could write to Mr Spencer once a month; those not club members could not have the privilege. Club members could vote. Voting was to them, a wonderful thing. I read the names of the pupils who were to be the charter members; and told them for a while we would hold an election once a week, and, if their work was good enough, others could come into the club. Out of the 12, six were chosen to frame the constitution. The constitution adopted required that every child's standing should be 90% to remain in the club. They required more than I expected. If any member of the club was not almost perfect in deportment, by a two thirds vote of the school, not of the club, he should be dropped till he recovered. If the work was below 90, he was not required to do any club work, so that he might have an opportunity to catch up in his studies.

The plan succeeded, I think, because last year, after the club was organized, I had six cases of tardiness against 73 the year before. This year, two cases. One child came without his shirt waist because he was not going to miss the talk. His mother came 10 minutes later, very much disgusted. She had the shirt waist. As for discipline, we suspended two pupils during the year. One was dropped for fighting on the way home from school. He is back in the club this year. Out of 38 children the week before last, we had 28 members. The other 10 scholars are striving hard. Some have 88 and are trying hard for 90. The language work has improved. They write the letters at home. Those who are not members write more than those who are. I showed the members' letters to two ladies, and they read 17 letters before they stopped. They enjoyed them. Every one by eight year old children.

In September we began studying seeds. Then we studied grasses and then began to study the soil in which these things grow. We live in the suburbs, and could look at the soil. We

made window boxes and planted these various seeds and watched them grow. We next studied the nature of the soils in the country where the fruits we have grow. In fact, we have done all our fourth grade geography work since September, and are getting the fifth year work well in hand. They work all the time that way. We don't seem to do any nature study proper. It just seems to go in with the school work.

We have five caterpillars; we had one to begin with. They live in a cricket cage. One boy is very fond of them. The children used to take turns in carrying them around in their hands. One boy would occasionally manage to keep one in his pocket. One day we had a caller. The smallest caterpillar used to take excursions for about an hour and go back to its cage. This lady stepped on it. We thought it was dead, but after a little while the caterpillar was crawling around. The next day the lady sent down four caterpillars to make up for the one. Out of school hours, the five are usually crawling around on some boy's hand, while some one is playing a mouth organ to see if they can hear. Occasionally a caterpillar will rear its head, and they insist it can hear.

I did not know that I was undertaking nature study work when I began. I was always out of doors with my father on the farm. I would often sit half a day in an appletree and watch a bird build a nest. In high school I had physics, which helped me a great deal. Physiology did not help much, so far as I know. Physical geography helped me about climate and atmosphere, while much reading helped a great deal. I told the children I knew nothing about nature study and took the attitude of a learner with them. That is why they have worked so faithfully with me.

Mine is practically a rural school. We have about 80 children in the school. I have 38. There is no work of this kind done in the higher grades.

About the kinds of soil—we found the kind in which the grass grew. As there is a hotel in the place, I spoke to the keeper for her tin cans. The boys made window shelves. We

had good success with the seeds. One father came to me and wanted to know something about rotation in crops. He asked me what to plant next year after potatoes.

Mrs Mary Rogers Miller—Miss Hill, of Syracuse, has had problems which have been somewhat different from Miss Whittaker's and Mr Drum's. She will tell us how she managed them.

Miss Mary E. Hill—I am a teacher in a private school, and I have the charge of nature study work and also teach two sciences. Having only 10 minutes, I wrote out some of the preliminary things I wish to say; and, then, I have some of the children's work which I thought would illustrate a little my matter.

Nature study was introduced into this school about four years ago, and was soon after made a permanent part of the work. I found to my surprise that the oldest class had some decided opinions which had to be overcome. Previous to this time I had not taught young children. I had taught science work to older children in other schools, so that practically the nature study itself was a little new, as nature study is not taught exactly as the sciences are, though the method is fundamentally the same in all nature study.

Of course, as everywhere, the children are given the living specimens, and learn to make their own observations. We use drawing, because I think it is exceedingly valuable in making them see exactly and find out what they have not seen just right. The trips and field excursions are an important part of the work, and I have as many as possible, though fewer than I wish. At first it was hard to get the children together because they had many outside interests. Boys' athletic clubs interfered a great deal, and one of the highest tributes to the work was given by a small boy on one of these trips. He looked up with a glowing face and said: "*This* is as good as baseball." Another boy said he would rather have a week in the country than a month in the city. One of the things which is encouraging to me is that they do things at home without being told to do them. I found that suggestions to do things at home did not always

bring good results; so I ceased to give them, because I found that, if they were interested, they would do things without being told, and, if they were not interested, they forgot. Sometimes they bring things to the class, which I use. I always use these specimens because I wish to encourage the children to bring them, but never depend on the children to bring material at all. One child saw two woodpeckers fighting in the spring. Though I don't like to use dead material, I did use those to show the interesting features of woodpeckers. Another child brought a live bat. That was an interesting study. It was a good subject for study. One thing I remember they said. When a bat was disturbed, it gave out "a nice perfumy smell." It is true. I never knew that; and some people might not consider it as pleasant as the children did. He climbed about on the netting and, when let out purposely, he flew about and fell on the floor. They found he could not stand on account of the way his legs were attached to the wings.

I find also that in the summer, after their vacations, they have a great deal to tell me when they come back. Most of them are fortunate enough to spend their summer vacations in the country. They sometimes repeat work at home that is being done in the school.

I have this fall a new room for the work, which is very large and light, having seven large windows which look out on the yard, in which a number of trees are growing, some young and some old. I have a better opportunity than before to study the trees, and have been giving the children some lessons on the study of trees for several seasons, for the sake of teaching them in a general way the characteristics of the trees; that trees are not at all alike; that they have characteristic growth; and are a little different when young from what they are when old. Across the street, beyond the fence are old elms, and in the yard, young elms. They see relation between old and young, and with a little suggestion have learned why there are no lower branches on the elm trees. I found perhaps more strikingly illustrated than ever before, the fact that drawing does make

them see better, because some wanted to make the tree fork too high or too low or spread apart too much after it had divided, and they made certain other mistakes. I tried two ways of making them draw; one by measuring and the other by judging roughly, which answers better than measuring exactly. At least I got better results with these young children.

I have evidence that certain results are being obtained; certainly that love of nature has been awakened, and observation quickened; they are seeing that things do not happen, and that things are not always what they seem at first sight; that nobody knows everything about anything; and they may find out more. Humane consideration for the lower forms of life is being strengthened. Instead of being afraid of spiders and caterpillars and other things which have been thought ugly, they find them interesting objects for study. I find, too, that it is of value when children come to the study of the high school sciences. They know better what is meant and do better work. I also find that the children who come into the higher grades of the intermediate department who have not had this work are very much at a disadvantage with the other children. There is no spirit in the class against the work, as there was. It may be partly due to my experience with younger children, but that is the fact.

We have been studying the cocoons of the spider this fall. I have not had time to mount the work in a way to let it be seen. We found them in great abundance on the sweet clover, and they looked a little like some cocoons we had before, except in shape. We opened them and found the egg masses within. In some were the young spiders, motionless, but, on stirring them, they moved about. We also found some of the empty eggshells, looking like white powder inside. Immediately after having seen some of the egg masses, the children concluded that they were the "skins" of the egg. Some thought at first that the hole in the top of the cocoon was for the young spiders to get out and come in. Another suggested it might be to give the spiders air, which was probably the case. This study is not yet

finished, because we want to see what will happen by spring. Those deprived of their covering are not dead. I will show a few specimens of the work.

[Miss Hill exhibited specimens of the drawings made by the children and compositions written by them. The remainder of her talk was explanatory of the illustrations.]

Miss Bessie Dewitt Mershon—It is unfortunate that at this point the program must be changed from the informality of the last half hour to a written paper; but, fortunately or unfortunately as one chooses to think, I was brought up a "blue presbyterian" and so find it very difficult to collect my thoughts when before an audience of this kind.

My training for this nature work has been little so far as schools are concerned. During my school course I had one term's work in botany—just enough to let me peep into that great Book of Nature and make me want to know more. So ever since, I have been at work with botany, zoology and geology. My teacher for the greater part of the time has been Mother Nature; my lessons were the fields and meadows with the Book of Nature; my helps have been any book or paper I could find on the subject in hand; but none were so true as that great world-wide book.

My nature work teaching began in Springfield Mass., where the work was planned by our able supervisor, Miss Stebbins. I was fortunate enough to be able to go out a few times into the fields with Miss Stebbins, where she made me feel with Stevenson:

> The world is so full of a number of things,
> I'm sure we should all be as happy as kings.

Since coming to New York state, I have been studying under the direction of the home nature study bureau of Cornell; and, if I were able, I would beg, urge, yes and implore every teacher in the state to follow the same course, and I only wish it were possible for every one in this country to do so. It is well worth all the time and trouble, which to me meant nothing but writing down the answers, for the observations were carried on in the

fields with the children, where children and teacher were alike learners.

As to the bringing of the work into the school, I can not speak strongly enough in its favor. But in order to make the work successful, as in everything else, it is necessary that the teacher enter into it with her whole heart, for, as an author has said, "The difference between half a heart and a whole heart makes just the difference between signal defeat and splendid victory."

Another great aid to my work has been that of having a junior naturalist club in my room. Oh, you teachers who have not tried to have such a club do not know what riches you are missing! No work is added to that of the teacher, but rather she receives much help, as the children like the idea of being members of a club; and then the leaflets which come each month to each child as well as the letters from "Uncle John" are looked forward to the whole month and are very helpful. My experience has been that the children's eyes are opened to the many beauties of nature which they had been passing almost daily unnoticed. Mrs Browning has written:

> Earth's crammed with heaven,
> And every common bush afire with God;
> But only he who *sees* takes off his shoes:
> The rest sit around it, and pluck blackberries.

If we teachers can lead the children to *see* one hundredth part of the beauties of nature, we may be happy. If we can only feel what Dr Payson said long ago to some teachers!

What if God should place in your hand a diamond and tell you to inscribe on it a sentence which should be read at the last day, and shown there as an index of your own thoughts and feelings, what care, what caution would you exercise in the selection! Now this is what God has done. He has placed before you the immortal minds of your children, more imperishable than the diamond, on which you are to inscribe every day and hour, by your instructions, by your spirit, or by your example, something which will remain and be exhibited for or against you at the judgment.

If this be true—and I believe every word of it—what better can we do than lead these children intrusted to our care, to see

the beauties of nature, and to observe some of its laws? Where can the idea of water partings, river basins and systems and the divisions of land and water be more easily taught than on some sloping ground during one of our thaws? We have had very enjoyable times when the pupils, after working with the sand table in the schoolroom, have gone out to a gentle slope near the school and with long sticks pointed out the various things. I have never found children getting cape and peninsula or isthmus and strait confused after a lesson of this kind. And oh, how they do enjoy the lesson!

At one time we had a glass fruit jar brought into the schoolroom. It was partly filled with soil from an ant hill with a number of ants. A thick brown paper was wrapped around the jar to keep it dark, and it was left for several days with a lump of loaf sugar on top of the ground. When we took off the paper, we found that work had been going on all the while. Two large halls were found close to the glass, leading from opposite sides of a room which was evidently the nursery, for in it were two pupa cases.

After this experience I found that the children no longer desired to kill the ants which they saw running over the walks. In fact, one active boy told me he had spent nearly two hours one Saturday morning watching some ants at work at one of their hills. I knew from what he told me that he had been thoroughly in earnest.

One morning last spring one of my boys came running up to our room, followed by about a dozen others. Everyone was looking troubled, and my boy was bareheaded. As soon as they reached the room, Charles asked very earnestly, "Can't I go back to Plant street and put this bird back in its nest?" I looked and saw that he had put the bird in his cap, so as to have it as comfortable as possible. I also saw that the bird was nearly dead, so asked him if he did not think he could put it into one of the trees near the school just as well. He looked up to me with an expression one could not possibly refuse and said,

"But its mother is crying up there on Plant street." When he returned after putting the little one in its nest, his face showed that he felt,

> If I can stop one heart from breaking,
> I shall not live in vain:
> If I can ease one life the aching
> Or cool one pain,
> Or help one fainting robin
> Unto its nest again,
> I shall not live in vain.

Dr Johnson said, "To cultivate kindness is a valuable part of the business of life." Another author has well said—what I think our nature work is doing:

> Man has one power in particular, which is not sufficiently dwelt on, it is the power of making the world happy or at least of so greatly diminishing the amount of unhappiness in it as to make quite a different world from that which it is at present. The power is called kindness. The worst kinds of unhappiness, as well as the greatest amount of it, come from our conduct to each other. If our conduct were under the control of kindness, it would be nearly the opposite of what it is, and so the state of the world would be almost reversed. We are for the most part unhappy because the world is an unkind world. But the world is only unkind for the lack of kindness in us units who compose it.

Hence we may conclude that "the child who is kind to animals will never forget his obligations to his fellow men."

Early last June we had a very happy surprise on opening an express package from "Uncle John" to find it contained a number of silkworms. We placed them in a terrarium made of wire netting, and two boys were delegated to go for the mulberry leaves each day. In a few days one of the caterpillars stopped eating, and in the morning we found a beautiful cocoon. The children were greatly excited as to what should be done with the silk. I heard them discussing it together before school, and finally one of them came to me and asked what I was going to do with the silk. I said that I had not yet decided, and then asked him what he would like to do with it. He said, "Oh, we all want you to have a silk waist out of it." I did not wish to throw cold water on such generosity, so I thanked them and

said, "We will see about it." In a few days, after we had had some lessons on the silk cocoon, we unwound a part of one of them and then raveled out a very small piece of ribbon, and the children saw for themselves what I did not want to tell them, that to make a waist we should need many, many more cocoons than we had.

Our field lessons form one of the most enjoyable features of our work. When teacher and 48 pupils turn their backs on school and books and city streets to go forth into some wide field or woods, only those who have tried it know the feeling of freedom which comes over every one of the number.

One class which I had been teaching in the heart of a city, when first taken out into the fields, was very expressive of this feeling. As the first boy entered the field, he turned a somersault. He just had to, and quicker than it takes me to tell it every boy followed suit; some of them two or three times. I wondered, as I stood there watching and enjoying the performance, what an onlooker would think of my class and my control of it, but, thinking I knew my boys, I did not worry. As soon as they had thrown off the crowded city feeling, every boy stood with head up and feet down ready to look for the things we had gone to seek. That day we were to look for leaf-miners and galls, and we found that

> There's never a leaf nor stem
> Too lowly for these tiny creatures.

Another field lesson was to see how many different ways plants have of scattering seeds, and it was surprising to see the number of ways found, and oh! the shout of joy that went up when we came under a chestnut tree, the first frost of the season having come the night before. I was reminded of the little poem about the chestnuts, so the next morning had it written on the blackboard for the benefit of the children.

> The chestnuts closed their purses tight,
> But Jack Frost opened them all last night.
> I think some time I'll sit up and see
> When he opens the burs, if he won't show me,
> For I've wondered so, and I wish I knew
> Why he don't get pricked, as my fingers do,
> And I can't see why, after all his fuss,
> He leaves them here on the ground for us.

We have had toads, fishes, frogs, crickets, grasshoppers, caterpillars, etc. in our room, and I find that having them there is an aid in discipline. At one time I had a boy with an exceedingly quick temper; he would strike and say the most unkind things on the least provocation. One day he asked me if he might care for the fish. I said, "John, if you could keep your temper I would be glad to have you care for them; but you know those fish might not do just as you wanted them to, and then we might have a dead fish, a broken globe and worst of all an angry boy." He went back to his seat angry, but in a few minutes he came back smiling and said, "Miss M., if you'll let me care for the fish, I'll try to keep my temper." He cared for them from that time, and I am thankful to say he tried hard to keep his temper.

Another case where nature work has helped me was in the case of a boy who entered my room several weeks after school had begun. All over his face were written obstinacy, sullenness, ugliness and everything disagreeable. I watched him carefully without his knowing what I was doing and concluded that he had made up his mind he was a bad boy because every one expected him to be, so he would not disappoint them. On this conclusion, I thought perhaps I could reach him by asking him to help me clean the boards after school. Unfortunately I asked him before school was out, and he replied, "No, I don't want to." Though failing that time, I determined to keep on till I had found what that boy was interested in. In a few days I was rewarded during a nature lesson to find he had observed a number of things about the plants in our room which few others had seen. "Is this a clue?" I asked myself. It was a rainy day, and the entire school was working at a quiet lesson except Theodore, who showed by his every motion that he did not intend to write the lesson. Apparently I did not see his attitude, but went to him and whispered, "Theo, do you think you could carry the large fern down and put it in the rain without getting wet, yourself?" How the expression of his face changed! He was trusted to do an errand and to care for a *plant*, that which I afterward found was one of the dearest of

things to him. Later on, when I gave out some seeds for them to plant at home, I found no one more interested than he, but it was a sort of secret between us. I think, if I had once spoken of it in any way before the class, he would have gone home and pulled up every plant, rather than have anyone else know that he cared. I can not tell anything more of this boy, as he moved away after being with us but two months. I was very sorry to have him leave.

There is nothing concerning which children will talk so freely as live creatures and plants, things which they can watch. In these talks how much a teacher may learn of that inner self which she may never otherwise see; and, now that our Bible is taken out of our schools, how are the children to learn of the Creator of all these things if not through the things which He has created? We are thankful indeed that, though the Book of Life has been taken from them, no one can take the Book of Nature.

When Earth's last picture is painted and the tubes are twisted and dried,
When the oldest colors have faded, and the youngest critic has died,
We shall rest, and faith, we shall need it—lie down for an eon or two,
Till the Master of all Good Workmen shall set us to work anew!

And those that were good shall be happy; they shall sit in a golden chair;
They shall splash at a ten league canvas with brushes of comet's hair;
They shall find real saints to draw from, Magdalene, Peter and Paul;
They shall work for an age at a sitting and never be tired at all!

And only the Master shall praise us, and only the Master shall blame,
And no one shall work for money, and no one shall work for fame;
But each for the joy of the working, and each in his separate star,
Shall draw the Thing as he sees it, for the God of Things as they Are.

Prin. R. J. Round—I have been asked to talk 10 minutes on nature study as it exists in Elmira. Several years ago, when I was principal of a grammar school in Elmira, we were required to observe Arbor day one day in every year, at which we had exercises; and, after we had observed the day for several years, it grew rather monotonous, the same subject recurring every year. I felt at that time if we could have greater latitude and

take in not only trees but all kinds of plants and all kinds of life, in other words, if we might call the attention of the children to the life about them, it would be a good thing for the scholars. Just about that time the nature study work of the Junior Naturalists Club of Cornell University was started; and I felt that there was my opportunity, and I think that I was one of the first, certainly in Elmira, who availed themselves of that opportunity. We formed clubs, and we have done more or less work. In the schools of Elmira no work in nature study has ever been required in the course. It has been left optional with the principals, and the principals have largely left it with the teachers, so that the work has been necessarily very crude and fragmentary; but I imagine that most of us are in the same position. It is still in the experimental stage, though it has done a great deal of good. We have accomplished much, though our work has been unsatisfactory. At first we received the leaflets, and we gave as much attention as we could to them. We wrote the letters, and later we have been doing the work in the schoolroom. Last spring Miss McCloskey visited our schools. She brought with her a number of objects to show the children, and she talked to them about the monarch butterfly, which I suppose you know is on the Junior Naturalists' button. She described the green chrysalis with the gold nails; and, as I sat listening to her as she talked to a room full of children, I thought what a beautiful thing it would be if we could have this chrysalis in our room to show to the children. I never had seen the chrysalis of a butterfly. I had seen the cocoons of moths. Those are very common, and most of us have had them in our schoolrooms. I thought if we could only get such a thing as that to show the children, what an interest would be created. It was my privilege to attend the summer school at Chautauqua last summer and become a member of the class in nature study. While there, the larvae of the monarch butterfly were brought into the classroom; and we watched the chrysalides day by day till the butterflies emerged. I felt if I could go home and have that reproduced in our schoolroom it would be a great

thing, but I had no idea whether I would succeed or not. I started out one Saturday morning with some of my boys to see if we could find some caterpillars on the milkweed. We found a great many milkweeds, but we did not find a caterpillar. On Monday I told the rest of the class that we had tried and that we had failed, and asked them if they would try. A day or two afterward some of the boys brought in some milkweed larvae with the milkweed, and we made a cage. We had a large glass jar, and we tied mosquito netting over the top. We had several of the cages, and the feeling spread to the other rooms, and in four different rooms we had the caterpillars of the monarch butterfly feeding. To make a long story short, the children watched those with great interest; and finally those caterpillars hung themselves up with the fish-hook shape, as you who have seen them know, and the transformation took place, and the butterfly chrysalis with the gold nails was perfect. We had those in several rooms. We watched them with great interest till finally we were rewarded by having the butterflies come out.

Now, that was the realization of a dream, a dream that I had six months before when Miss McCloskey had been there and told us about these things. None of us had ever seen them. I had lived to be over 50 years old and had never seen such a thing, and yet with no difficulty we realized this dream. The pupils in the four highest grades, numbering 150, saw the metamorphosis. They saw everything except the eggs. We had none of the eggs. If we never do anything more in nature study for those pupils, we have accomplished a great deal; and I never expect to get more pleasure out of any school work than I did out of that experience. This is told as an illustration of what we can all do. I never had any special training in science, and I do not feel myself qualified to do this work; yet the children had the opportunity to observe closely and carefully a most wonderful thing in nature that is going on around us all the while.

We have these clubs in all of our grades of the school from the fourth to the eighth, inclusive. Each member of a club writes a letter a month to Mr Spencer. While the pupils were watching these changes, I assembled two of the classes every morning and for 15 or 20 minutes I talked and read to them about moths and butterflies. I simply made an illustration, made a type of the caterpillar, of the monarch butterfly. We had other caterpillars, and the cocoons were found in the schoolroom. We have had silkworms and the same experience spoken of by the last speaker. Mr Spencer asked us if we would like some of the caterpillars. I said yes, but I did not know how we could feed them. I did not know that there was a mulberry tree in the city of Elmira, but, on my inquiring of the children, they said, "Yes, there is a mulberry tree in the next yard". That is an illustration of what we can do if we try. We had the leaves brought in and the caterpillars or silkworms fed and the cocoons spun, and we kept them till the moths came out and laid their eggs. So we had the complete metamorphosis.

Of course, the changes took place slowly. The children observed and at the end of the month wrote their letters. In our grammar school conference yesterday, we discussed the subject of composition writing, and I have felt that the nature study work has been a great help to our pupils in the matter of composition writing; and you saw the work there in drawing. The nature study work is very helpful in drawing and composition. The children like to write if they have something to write about. Those of us who in our early days had to write compositions and did not know what to write about had great difficulty; but, if you give children every month some material to think about, and they work it up and take notes, when they come to write, they have something to say from their own experience.

Mention has been made of the excursions and the walks. We have done something of that. Last spring I went out with a number of my classes. Each took along a little basket and a

little notebook and pencil. We went out into the woods and fields, and every bird that we saw we made a note of. Everything peculiar about it we noted; and then gathered the wild flowers, as many as we could, and brought them to the schoolroom the next morning. We put on the board lists of the birds we saw. The supervisor in drawing was around that morning and took advantage of the opportunity to give a lesson on drawing these wild flowers. The drawing teachers are ready to cooperate with us; they are glad of the opportunity it furnishes to create an interest in the drawing.

The greatest difficulty I find is this: teachers as a rule are willing and glad to do this work, but they can not do successful nature work without taking some time. They have to provide specimens. Every teacher can do it, I am sure, without any previous preparation. Of course, if a teacher's attention has been directed to the study of botany or of entomology or zoology, she is better prepared for it, but every teacher can find some subject in which the children can be interested. With our modern curriculum, with the multiplication of subjects, the grade teacher has difficulty in finding time. With a supervisor of drawing, music and physical culture, and with a principal who is not particularly interested in the nature study, it is hard for a teacher to get the time to spare. I have been interested in nature study, and my teachers have known it, and have been perhaps more willing to work than the teachers in a school where the principal is not particularly interested. Even in my school I have felt a hesitation in urging the teachers to do this nature study work. I do not know how we are going to solve the problem. Our state superintendent, in his last report, called attention to the fact, and this is not the first time he has done it, of the overcrowding of our courses of study; and he spoke of it in an address to the grammar school principals yesterday morning. I say I do not know how we are going to overcome this difficulty, but I do believe most thoroughly that, if the grade teachers could be given the time to make the preparation, and through all the grades some time of the week could be given to the subject of nature study, there would be

a marked improvement not only in the moral character of the pupils, but in all the work done in our schools.

One thing has been a great comfort to me. Mrs Comstock gave utterance to this thought in the talks to the teachers at Chautauqua. She issued for the use of the teachers a syllabus, giving an outline for each grade for each season of the year. There is a great deal of work suggested, and that frightens the teachers. Mrs Comstock said this, and I have said the same thing to my teachers: Do not be afraid to take hold of this work because there is so much to be done. Look over the outline. You will find something there that you are interested in, and of which you have some knowledge; and if in the term you only get the children to study carefully and closely some one thing, you will have accomplished a great deal. I have carried out this thought and, as I told you, made a beginning in our study of the metamorphosis of the monarch butterfly. If we do not do anything more this year than that one thing, I feel that we have done a great deal for those children; and I believe every teacher can do as much. She can find some one object and bring the living creature, either plant or animal, into the room and watch the changes. Call attention to the details and get the children to describe them. That is a beginning, and that beginning we have made.

Saturday, 11.15 a. m.

GENERAL SESSION

A STANDARD COLLEGE ENTRANCE OPTION IN BOTANY

COMMITTEE REPORT[1]

PRESENTED BY PROF. FRANCIS E. LLOYD, TEACHERS COLLEGE, COLUMBIA UNIVERSITY

1 It is founded on the two important reports of the National Educational Association, the report of the Committee of Ten (Washington 1893), and the report on college entrance requirements (Chicago 1899).

2 It is intended primarily as an option for entrance to college, but equally for the education in the high school of the general student who can follow the subject no farther; there are in

[1]The committee was appointed by the Society of Plant Morphology and Physiology.

botany no advantages in having the college preparatory and the general educational courses different, at least none that are at all commensurate with the additional burden thus laid on the schools.

3 It should, if possible, be founded on a considerable body of botanical fact learned through "nature study" in the lower schools; it should form part of a four years high school course in the sciences; it should be considered and treated as an elementary or preliminary course leading to second courses in colleges, and colleges accepting the option should make provision to articulate second courses economically with it.

4 The immediate plan of its construction is very simple, namely, to include those topics in the leading divisions of the subject which most teachers now regard as fundamental, either for their value in scientific training, or as knowledge; but the individual teacher is left free to follow his own judgment as to sequence of topics, text and other books and special methods. Advice is occasionally offered, however, on important points in which most teachers are now known to agree.

5 It is designed to yield a mental discipline fully equal in quality and quantity to that yielded by the older subjects studied for the same length of time.

6 The time per week, inclusive of recitation, preparation, and laboratory, should be the same as for any other subject. Where five periods a week with an hour of preparation for each are demanded for other studies, this course should receive the equivalent of two recitation periods with their preparation, together with three double (not six separated) periods in the laboratory and a small amount of outside related work or preparation. Variation from this should be toward a greater, not a lesser proportion of laboratory work.

7 The preparation of records of the laboratory work, in which stress is laid on diagrammatically accurate drawing and precise and expressive description, is regarded as an integral part of the course; and these records, preferably in a notebook, must be presented with the examination paper, and will count one third toward admission.

8 There must be provided

a A full year option

b A half year option

c The possibility of a two year option

Specifications

The full year option, to count as 1 unit or point out of 13 to 15 for entrance, will consist of:

1 A half year devoted to the general principles of anatomy, morphology, physiology and ecology.

2 A half year devoted to the natural history of the plant groups, with classification.

Under special circumstances, though it is not advised, the full year option may consist of 2 enlarged to occupy a year and including the essentials of 1.

The half year option, to count as 1 unit or point out of 26 to 30 for entrance, may consist of either 1 or 2 above, but not of a composite of both.

A half year option consisting of a composite of 1 and 2, though recognized as profitable under some local conditions, is not here included; since, while it is not considered educationally superior, if equal, to 1 or 2 more throughly studied, it will be impossible for colleges to make arrangements to articulate it profitably with their higher courses in addition to 1 and 2; and, moreover, examination boards will find obvious difficulties in providing examinations for it.

The two years option will consist of 1 enlarged to a year, together with 2 enlarged to a year.

1 The half year option in the general principles of anatomy, morphology, physiology and ecology

The fundamental topics are the following:

a In anatomy and morphology

The seed. Four types (dicotyledon without and with endosperm, a monocotyledon and a gymnosperm); structure and homologous parts.

Food supply; experimental determination of its nature and value. Phenomena of germination and growth of embryo into a seedling (including bursting from the seed, assumption of position and unfolding of parts).

The shoot. Gross anatomy of a typical shoot; the arrangement of leaves and buds on the stem, and deviations (through light adjustment etc.) from symmetry.

Buds, and the mode of origin of new leaf and stem; winter buds in particular.

Specialized and metamorphosed shoots (stems and leaves). General structure and distribution of the leading tissues of the shoot; annual growth; shedding of bark and leaves.

The root. Gross anatomy of a typical root; position and origin of secondary roots; hair zone, cap and growing point; origin of new roots.

Specialized and metamorphosed roots. General structure and distribution of the leading tissues of the root.

The flower. Structure of a typical flower, specially of ovule and pollen; nectar glands; functions of the parts. Comparative morphologic study of six or more different marked types, with the construction of transverse and longitudinal diagrams.

The fruit. Structure of a typical fruit, specially with reference to changes from the flower, and from ovule to seed. Comparative morphologic study of six or more marked types, with diagrams.

Where options 1 and 2 are combined to form a year course, this comparative morphologic study of flowers and fruits may advantageously be postponed to the end of 2, and then taken up in connection with classification of the angiosperms.

The cell. Cytoplasm, nucleus, sap cavity, wall. Adaptive modifications of walls, formation of tissues.

The sequence of topics above given, with the exception of the position of the cell, is that recommended by the committee, but the precise sequence is not considered important.

As to the study of the cell, it is by no means to be postponed for consideration by itself after the other topics, as its position in the above outline may seem to imply, but it is to be brought in earlier along with the study of the shoot or root, and continued from topic to topic. Though enough study of the individual cell is to be made to give an idea of its structure (a study which may very advantageously be associated with the physiologic topics first mentioned under *b*) the principal microscopic work should consist in the recognition and study of the distribution of the leading tissues.

b In physiology

Rôle of water in the plant; *absorption (osmosis), path of transfer, transpiration, turgidity and its mechanical value, plasmolysis.*

Photosynthesis; *dependence of starch formation on chlorophyl, light and carbon dioxid; evolution of oxygen,* observation of starch grains.

Respiration; *necessity for oxygen in growth, evolution of carbon dioxid.*

Digestion; *digestion of starch with diastase,* and the role of digestion in translocation of foods.

Irritability; *geotropism, heliotropism* and *hydrotropism;* nature of stimulus and response.

Growth; *localization in higher plants; amount in germinating seeds, and stems; relationships to temperature.*

Fertilization; sexual and vegetative reproduction.

Though for convenience of reference, the physiologic topics are here grouped together, they should by no means be studied by themselves and apart from anatomy and morphology. On the contrary, they should be taken up along with the study of the structures in which the processes occur, and which they help to explain; thus, photosynthesis should be studied with the leaf, as should also transpiration, while digestion may best come with germination, osmotic absorption with the root, and so on. The student should either try, or at least aid in trying, experiments to demonstrate the fundamental processes underlined above.

c In ecology

Modifications (metamorphoses) of parts for special functions.

Dissemination.

Cross-pollination.

Light relations of green tissues; leaf mosaics.

(Plant societies; mesophytes, hydrophytes, halophytes, xerophytes; climbers, epiphytes, parasites (and saprophytes), Insectivora. Symbiosis)

(Plant associations, and zonal distribution)

The topics in ecology, (particularly the first four and in part the fifth) like those in physiology, are to be studied not by themselves, but along with, and in dependence on, the structures with which they are most closely connected, as cross-pollination with the flower, dissemination with the seed, etc. The fifth and sixth may most advantageously be studied with *g* in part 2, and are to be considered as recommended rather than as required.

In this connection field work is of great importance, and for some topics, such as the sixth, is indispensable, though much may be done also with potted plants in greenhouses, photographs, and museum specimens. The committee strongly recommends that some systematic field work be considered as an integral part of the course, coordinate in definiteness and value as far as it goes with the laboratory work. The temptations to haziness and guessing in ecology must be combated.

2 The half year option in the natural history of the plant groups, and classification

A comprehensive summary of the great natural groups of plants, based on the thorough study of the structure, reproduction and adaptations to habitat of types from each group, supplemented by more rapid study of other forms in those groups. Where living material is wanting, some use may be made of preserved or even pictured materials. A standard textbook should be carefully read. The general homologies from group to group should be noted.

In general, in this part of the course, it is recommended that much less attention be given to the lower, difficult and inconspicuous groups, and progressively more to the higher and conspicuous forms, and that at least one third of the time devoted to the groups be given to the spermatophytes. Attention should be called throughout to the economics (relation to man's good and injury) of the forms and groups studied.

Following is a list of recommended types from which selection may be made.

a Algae. Pleurococcus (or Sphaerella), Spirogyra, Vaucheria, Fucus, Nemalion (or Batrachospermum or Polysiphonia or Coleochaete).

b Fungi. Bacteria, Rhizopus, yeast, Puccinia (or any powdery mildew), mushroom.

Bacteria and yeast have obvious disadvantages in such a course, but their great economic prominence may justify their introduction.

c Lichens. Physcia (or Parmelia).

d Bryophytes. In Hepaticae, Radula (or Porella or Marchantia). In Musci, Mnium (or Funaria or Polytrichum).

e Pteridophytes. In Filicineae, Aspidium or equivalent, including of course the prothallus.

In Equisetineae, Equisetum.

In Lycopodineae, Lycopodium and Selaginella (or Isoetes).

f Gymnosperms. Pinus or equivalent.

g Angiosperms. A monocotyledon and a dicotyledon, to be studied with reference to the homologies of their parts with those in the above groups; together with representative plants of the leading subdivisions and principal families of angiosperms.

Classification should include a study of the primary subdivisions of the above groups, based on the comparison of the types with other (preferably) living or preserved material. The principal subdivisions of the spermatophytes, grouped on the Engler and Prantl plan, should be understood.

The ability to use manuals for the determination of the species of flowering plants is not considered essential in this course, though it is desirable. It should not be introduced to the exclusion of any other work, but may well be made voluntary work for those showing a taste for it. It should not be limited to learning names of plants, but should be made a study in the plan of classification as well.

The preparation of a herbarium is not required or recommended except as voluntary work for those with a taste for collecting. If made, it should not constitute a simple accumulation of species, but should represent some distinct idea of plant associations, of morphology, of representation of the groups, etc.

SYMPOSIUM

WHAT OUGHT THE HIGH SCHOOL TEACHER IN EACH SCIENCE TO KNOW? WHAT OUGHT HE TO BE ABLE TO DO? WHAT ARE HIS OPPORTUNITIES FOR SELF-IMPROVEMENT?

Prof. Lyman C. Newell—What I shall say will be confined to the last of the three questions to be discussed in this symposium. The third question, "What are his opportunities for self-improvement?" is important, because it presents so many practical aspects. Perhaps the largest opportunity is access to periodical literature. Magazines devoted to every branch of science are numerous, and no progressive teacher can afford to lose sight of them. It is not always possible to read and digest an article as soon as it appears. Therefore teachers must have some plan of keeping track of helpful articles. Those who have never tried to do this may regard it as an almost impossible operation, but I have not found it so. An hour a month I have found sufficient to enable me to record on cards, about half the

size of an ordinary library catalogue card, the title, etc., of all articles in current magazines which I believe will be helpful. As soon as convenient I read the articles, abstract what seems advisable, or, as often happens, purchase the magazine and file it away for future use. The cards are filed alphabetically by topics, the simplest word being placed first, though the exact title is always put on the card. Some such plan is necessary if one is to prepare papers and to keep track of discoveries and the progress of principles. I recommend the card system after a trial of nearly 10 years.

A second opportunity for improvement is general reading, specially in one's special field. Teaching is apt to make one narrow. Our daily work does not open many different channels of thought and interest. Many teachers are deplorably uninformed in the different branches of their subject. So important is this matter in the opinion of the New England Association of Chemistry Teachers that a list of books in chemistry has been prepared by them. This list is devoted to the needs of secondary teachers, though others will find it useful. I have brought a number of copies of this list, and they are at your disposal. Additional copies may be obtained of the L. E. Knott Apparatus Co., 16 Ashburton place, Boston Mass. Many books have recently appeared on new subjects which will soon be taught in the secondary schools, and now is the time for teachers to acquaint themselves with the general outlines of these subjects. This is specially true of physical chemistry and electrochemistry. Several books on these subjects are described in the list just mentioned. In addition to the use of printed lists, teachers should not fail to improve themselves by examining new books as soon as they appear. Many hints are obtained from them. In this connection it may be well to state that teachers should keep track of good books. One's circumstances often change; a book not available in one place may be needed elsewhere. To be a serviceable teacher, one must be prepared to adapt one's self readily to new conditions.

A third means of improvement is illustrated by this very meeting. It has been an inspiration to me to meet teachers who

are working in the same line as I, though under different circumstances. In New England we have two science associations, one devoted to chemistry and one to physics. Each has a large membership, and is a source of profit and pleasure to the members. We give and take freely. No one attempts to take without giving in return. The records of the meetings are published in full and are freely distributed.

These three contemporary opportunities for self-improvement may be utilized without adding to our daily burdens, and in time they may become part of our literary recreation.

Prof. Henry R. Linville—I wish to speak of what seems to me to be the difference in value as teachers between the man who has had the conventional college course and the one who has done postgraduate work in a university. If it were possible to find two men of the same capacity, physically and mentally, that could be subjected to the same training up to a certain point, and led into different work after that, I am confident that a practical demonstration of the benefit of thorough work in the best graduate schools could be made. As things are, the comparisons that occur to anyone who thinks on this question are convincing. All of us are familiar with the average college graduate who in the first year after receiving his degree begins his career of teaching. He finds difficulties and in time overcomes them to the satisfaction of himself, his principal and the board. With 10 years of this experience he has made a place for himself in the list of steady and reliable teachers. This man can teach a class in Latin as well as in English or in mathematics, and all of them successfully in a place where the scholar's ideal of good teaching is not likely to be prevalent. Secondary schools are filled with this sort of men, and their presence is responsible for much of the mediocre, humdrum, spiritless work found in these places.

A man who pursues a consistent course of investigation in some special field is being trained (within the limits of his native ability) into the possession of one of the greatest powers of the human mind—the power of independent and accurate judgment. Such a man, with a natural capacity for teaching,

can become an immediate force in any institution. He is an abler man than he would have been without his special training. The manifestation of his ability need not be limited to any particular line of work. His judgment has been trained, and the trained judgment may be used in various directions. The teaching of this sort of man has every reason for being characterized by high quality, spirit and inspiration.

When a teacher regards with thorough and intelligent respect the principles of his science, he is undoubtedly in a position to inspire a similar respect for the science in the minds of his pupils. This is the ultimate proof of success.

Saturday afternoon

GENERAL SESSION

STIMULANTS AND NARCOTICS

REPORT OF PROGRESS OF THE COMMITTEE

PRESENTED BY PROF. IRVING P. BISHOP

At the meeting of this association held in New York in 1898 the attention of the council was called to certain discrepancies between the facts of physiology taught in the universities and medical schools and those taught in the public schools of the state. As the result of the discussion which followed, a committee of five was appointed "to ascertain and report what is definitely known regarding the effects of alcohol and narcotics on the human body and to recommend suitable methods for teaching the same in the schools of the state." A careful examination of the bibliography of alcohol alone revealed an enormous mass of matter, and a wide difference of statement on almost every point, even among those best qualified to know. As it was known that the Committee of 50 for the Investigation of the Drink Problem, a nonpartizan organization, was conducting original researches, your committee unanimously decided to defer its final report till the material from that source should be available. Recent correspondence with that body shows that the report of the subcommittee on the physiologic and pathologic aspect of the drink problem is now ready, and

that it will be in our hands soon. We present, therefore, certain features of our work which show the progress made to date.

Comparison of textbooks used in medical colleges and in the public schools of the state

To illustrate the discrepancies referred to in the opening lines of this report, we subjoin parallel quotations taken from textbooks used in the medical schools and universities and there considered standard and those in general use in the public schools of the state. With one exception—Hutchinson's—the latter are indorsed by the Women's Christian Temperance Union.[1]

[1] A part of the following quotations is taken from the advance sheets of the *Report on the Present Instruction in the Physiological Action of Alcohol* of the subcommittee of the Committee of 50 for the Investigation of the Drink Problem. Dr H. P. Bowditch, Prof. C. F. Hodge.

STANDARD TEXTS

It may, perhaps, be said with safety that in small quantities it (alcohol) is beneficial, or at least not injurious barring the danger of acquiring the alcohol habit, while in large quantities it is directly injurious to various tissues.[2]

In practice we find that in many persons a small quantity of alcohol improves digestion; and that by its means a meal can be digested which otherwise would be undigested and so wasted.[3]

In attempting fairly to estimate the action of stimulants, especially of alcohol, one point is of the utmost importance to remember. It is this—alcohol is a food. If alcoholic stimulants were mere disengagers of static force, early exhaustion would be the rule. But as alcohol is a readily oxidizable form of hydrocarbon, it is also a

[2] Howell. Amer. Textbook of Physiology. Ed. 2. 1900. p. 359.

[3] Fothergill. The Practitioner's Handbook of Treatment. Lond. and N. Y. 1897. p. 688.

SCHOOL TEXTS

Alcohol is not a food or drink. Medical writers, without exception, class alcohol as a poison.[4]

Alcohol is universally ranked among poisons by physiologists, chemists, physicians, toxicologists, and all who have experimented, studied and written upon the subject, and who, therefore, best understand it.[5]

Alcohol also is a poison. It deprives the bones of some of their food, and leaves in place of it, a mineral that makes them more brittle.[6]

As alcohol is a poison, it should not be taken into the stomach. What is a poison? Anything is a poison that harms the body and makes one sick. Alcohol does both.[7]

"Is alcohol a food?"

"What do you think about it? (question to the class)—Do you

[4] Eclectic, no. 3, p. 5-7.

[5] Quoted from Youmans in Blaisdell's no. 2, p. 232.

[6] Hutchinson. Our Wonderful Bodies, First Book, p. 24.

[7] Hutchinson. First Book, p. 46.

food as well as a stimulant. In fact it is one of the most easily assimilable forms of food, and very frequently it can be taken and utilized when no other form of food is available. While it is a stimulant, an evoker of force, it also supplies to some extent that force in its readily oxidizable self.' The experiments of the late Dr Anstie, and Dr Dupré have placed beyond all question or honest doubt the fact of the oxidization of alcohol within the organism. If alcohol is oxidized in the body, then alcohol is a true food, or furnisher of force.[1]

The question of the propriety of the daily use of alcohol by healthy men is at present a very serious one, involving so many moral and politico-moral issues that it can not be fully discussed here. Suffice it to state as obvious inferences from our present knowledge of the physiological action of alcohol, that the habitual use of moderate amounts of alcohol does no harm; that to a certain extent it is capable of replacing ordinary food, so that if it be scanty, or even if it be coarse and not easily digested, alcohol in some form or other, is of great advantage; that in all cases it should be taken well diluted, so as not to irritate the stomach; and that wine or malt liquors are certainly preferable to spirit.

As Liebig also found that this substance exists in the urine of dogs, horses and lions, and as A. Rajowski obtained it from healthy rabbits, it must be acknowledged that our present knowledge strongly indicates that it is formed and exists in the normal organism.[2]

[1]Fothergill. Practitioner's Handbook of Treatment. Ed. 11. Lond. 1897. p. 254.

[2]Wood, H. C. Therapeutics, p. 372.

think your body would grow and keep well and strong if you used it instead of bread and meat?"

"No, indeed. We know that alcohol is not a food."[3]

It is important for you to remember that alcohol is a narcotic poison.[4]

This alcohol is a liquid poison. A little of it will harm any one who drinks it, and much of it would kill the drinker.[5]

It must be remembered that in whatever quantity, or wherever alcohol is found, its nature is the same. It is not only a poison but a narcotic poison.[6]

Alcohol a Poison.

A poison is any substance whose nature it is, when taken into the body either in small or large quantities, to injure health or destroy life.

In large doses, in its pure state, or when diluted as in brandy, whiskey, rum or gin, alcohol is often fatal to life. Deaths of men, women and children from poisonous doses of this drug are common.

In smaller quantities, or in lighter liquors, beer, wine and cider, when used as a beverage, it injures the health in proportion to the amount taken.[7]

If on the other hand, you take into your stomach a little alcohol, it receives no such welcome. Nature treats it as a poison and seeks to rid herself of the intruder as soon as possible. Every organ of elimination, all the scavengers of the body—the lungs, the kidneys, the perspiration glands, at once set to work to throw off the enemy. The alcohol thus eliminated is entirely unchanged. It can not then be treated as an aliment or food.[8]

[3]Health Series, no. 1, p. 30 ff.

[4]Eclectic Series, no. 2, p. 31.

[5]Pathfinder Series, no. 1, p. 41.

[6]Authorized Series, no. 8, p. 58.

[7]Dulaney's Series, no. 2, p. 46 ff.

[8]Steele's Hygienic Physiology. 1884. p. 164.

Conflicting statements like the above could be multiplied far beyond the limits of this report, but enough have been given to show that, in the interpretation of facts, there is a lack of concord which is no longer tolerable.

Opinions of the committee regarding the effects of alcohol

In attempting to select from the material at their disposal such facts as might be safely taught, your committee has endeavored to weigh evidence carefully. When possible, it has availed itself of the latest research, placing much confidence in experimental inquiry where it has been carried on with due care and regard for accuracy. That there may be no misunderstanding as to the meaning of terms, the following provisional definitions have been adopted:

Stimulant. An agent which temporarily quickens some functional or trophic process. It may act directly on the tissue concerned, or may excite the nerves which effect the process, or paralyze the nerves which inhibit it. Stimulants comprise certain medicinal substances, as ammonia, alcohol and ethylic ether, as well as physical conditions such as warmth, cold, light, or electricity, esthetic effects, as music and other products of art, and emotions of various kinds, as joy, hope, etc. Stimulants have been divided into general and topical, according as they affect directly or indirectly the whole system or only a particular part. *Century Dictionary.*

Narcotic. An agent which directly induces sleep, blunts the senses, and in large amounts produces complete insensibility.

Poison. A substance which when introduced into the body causes disease or death.

Regarding the influence of quantity in producing toxic effects there is much controversy. One class of physiologists take the view that alcohol in any quantity is a poison, and the other, while freely admitting that pure alcohol or even strong alcohol, in large doses, may produce poisonous effects, believe that in small or moderate doses it is harmless or positively beneficial.

The former view is exemplified by the following extracts:

"Alcohol is a true narcotic even in small doses."[1]

[1] W. S. Hall. Elementary Anatomy, Physiology and Hygiene. 1900. p. 118. (Indorsed by W. C. T. U.)

"Alcohol is a poison of the narcotic class with a special tendency to act on the brain and nervous system."[1]

"There are no dividing lines on one side of which the poisonous action of alcohol can be seen, while on the other it is absent."[1]

"It is a scientific absurdity to assume that alcohol or any other substance is not a poison in small quantities but it is in large quantities."[2]

This view, however, is not that generally held by physicians and the authors of standard texts, who, with few exceptions, discriminate between the effects of large and small doses. For example, the *American Textbook of Physiology* says (p. 359): "The effect of alcohol upon the body evidently varies greatly with the quantity used." Indeed it seems probable that the effects of a drug may differ not only in degree but in kind. Prussic acid is a very deadly poison, and yet nature has put it into fruits which we consume not only with pleasure but also with impunity. The same may be said of oxalic acid, citric acid, etc. Even common salt may act as an emetic. Sound, light, heat and electricity furnish similar illustrations. In the judgment of your committee the same principle applies in the case of alcohol. While undoubtedly poisonous in concentrated form or in large quantities, it is apparently not so to adults when it is taken in small quantities and sufficiently diluted.

In attempting to decide what facts regarding the use of alcohol and its effects on the body may be safely taught, your committee has encountered an array of conflicting evidence which is extremely perplexing. There are very few points on which there is absolute agreement; in some cases the statements regarding the same topic are diametrically opposed.

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[1]"Alcohol as a Causative Factor in Disease of the Central Nervous System," T. D. Crothers M. D. Reprint from Journal of the Amer. Medical Ass'n. Ap. 9, 1898. p. 2 and 7.

[2]From a letter to the committee dated Dec. 18, 1901, signed by the three members of the special committee of the Onondaga co. Woman's Christian Temperance Union.

In view, also, of the probability that the report of the Committee of 50 for the Investigation of the Drink Problem will be published during the coming year, your committee has decided to postpone till the next meeting of this association its conclusions as to the action of alcohol on the various organs.

But, in order that there may be no misapprehension as to the convictions of the committee on certain practical points of supreme importance, we submit the following opinions and recommendations.

1 All writers agree that an excess of alcohol impairs certain functions of the cerebrum, for example, attention, memory and self-control, and that many cases of insanity are due to such excess.

2 What constitutes excess will differ with individuals, with occupations and with other conditions. On the present occasion your committee does not undertake to prescribe the limit of safety for the average adult.

3 The committee does not consider that the stimulative action of alcohol on the system as a whole has been demonstrated, nor is it aware that any authority claims that in health or under ordinary circumstances, alcohol is an *economical* food, whether for the production of heat or for the protection of fat or proteid.

4 As a matter of fact, the average man in health and under ordinary circumstances disregards these possible rôles of alcohol and takes it because of its flavor or because he finds it conducive to his personal comfort or to good-fellowship.

5 Your committee believes that *spirits* should never be used as beverages unless largely diluted, and that alcohol in any form should be taken only at meals and after the work of the day is done.

6 Youths, say under 21, should abstain altogether from alcohol, excepting under specific medical advice.[1]

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[1]The importance of this matter and the natural indisposition of youths to refrain from what is permitted their elders lead the committee to state the grounds of their recommendation categorically as follows:

1 Most parents prefer that their sons should abstain till of age.

2 Several college presidents have advised their students to abstain.

Opinions of educators on the present methods of teaching physiology

During the past year there have been conducted three separate inquiries, viz: (1) by the chairman of the committee; (2) by the chairman in conjunction with F. N. Jewett of the Fredonia (N. Y.) Normal School; (3) by J. E. Peabody as chairman of the subcommittee on teaching.

1 For the purpose of ascertaining the present status of physiology teaching in the state, circular letters of inquiry were mailed by the chairman of the committee to 450 teachers, the

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3 Among those who hold very liberal views as to the use of wine by adults, an experienced physician and an expert investigator of the whole subject wrote, respectively, as follows: "I exhort all young people in health not to adopt the practice of drinking wine." *Dr James Jackson* "For youths, say under 25, the proper rule is either no alcohol or very little indeed." *F. E. Anstie*

4 Analogous restrictions based on age are commonly recognized. The infant takes no solid food; the child retires early; the boy is spared severe labor; the responsibilities of marriage, of society and of political life are postponed till a certain development of body and mind has been attained. Is it not then prudent for the youth to defer the use of so potent an agent as alcohol at least till his majority is reached?

5 Seldom, if ever, is there at the outset a real liking for the taste of alcoholic beverages; on the contrary, their use is commonly begun in thoughtless imitation of older persons or of foreigners; an unworthy motive for doing anything of doubtful utility.

6 Comparatively few students live at home or take their meals at private clubs. At school and college boarding tables alcoholic beverages are seldom served; consequently they are likely to be used, if at all, at saloons, where the other conditions are more or less undesirable, and with little or no accompanying food. It is universally admitted that both the local and the general effects of alcohol are most pronounced when taken on an empty stomach.

7 To gain or hold places on athletic teams abstinence is generally required. Even German corps students are beginning to recognize the incompatibility of excessive beer drinking with proficiency in fencing.

8 The foundations of inebriety are commonly laid early. C. L. Dana found that of 210 inebriates nearly all began to drink before 30, and about two thirds before 20. *Medical Record*, July 27, 1901; *Quarterly Jour. of Inebriety*, Oct. 1901.

9 Youth is the age of peril; temptations abound without; appetites and passions are foes within; of all periods of life, in this should a man be ever "on guard," and protected by the community.

10 Habits are most readily and firmly established in youth. Of all the most valuable is the habit of self-control. "The world belongs to those who can control themselves"; but the man who uses alcohol in excess never can do that.

greater part of whom exercise some supervisory function and for that reason were supposed to have superior opportunities for knowing actual conditions. To avoid, as far as possible, a preponderance of local sentiment, these circulars were distributed over the entire state in cities, towns and villages of 1000 or more inhabitants. Of these circulars 203 were filled out more or less completely and returned. The replies are classified as follows:

Union and high school principals	106
City superintendents	32
Village superintendents (villages of more than 5000 pop.)	14
City grammar school principals	22
Special teachers of physiology	17
Normal school principals	7
Grade teachers	5
Total	203

For convenience, the questions and analyses of answers will be stated together.

Question 1 Do you regard as excessive the time now required by law for the study of physiology?

To this 139 or 68% answered "yes" and 63 or 31% answered "no."

Question 2 If excessive, would you change by decreasing subject-matter, or by limiting instruction to fewer grades?

Of the 126 answers, 100 or 79% were in favor of limiting instruction to fewer grades, five would decrease subject-matter, and 21 would do both.

Question 3 In the latter case, to what grades (school years) would you confine it?

To this 120 answers were received. Of this number 40 would begin work below the 6th year, and 80, or two thirds, would begin at the 6th grade or above. Of the latter division, 34 would begin at the 6th grade, 18 at the 7th, 18 at the 8th, nine at the 9th, one at the high school.

There were also some who preferred confining the work to a shorter time than four years. As a rule these were from the teachers who believe in teaching the subject as a science only, and in the higher grades or high school.

Question 4 In which school year should a textbook in physiology be first put into the pupil's hands?

Answers: 1st year, one; 2d year, one; 3d year, four; 4th year, 11; 5th year, 26; 6th year, 35; 7th year, 35; 8th year, 28; 9th year, six; 8th, 9th or high school, seven.

The reason given for not wishing to introduce a book earlier than the year chosen was in 38 instances, immaturity of the pupil; in six instances, difficulty of maintaining interest for so many years; and in four instances the belief that other work was of more importance. It is worthy of note that 80% of those answering preferred to begin the use of text in the grades included between the 4th and the 9th.[1]

Question 5 After having studied physiology through the grades, does the pupil now enter the high school with increased or diminished interest in the subject?

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[1]To ascertain how the point of view affected the answers, an analysis was made of the replies to the foregoing questions from superintendents, grammar school teachers and special physiology teachers. Of the 46 city and village superintendents, 64% answered "yes" to the first question. Out of their 28 replies to question 3, 64% wished to confine the work to grades above the 5th, and also to introduce the text at the 6th or some higher grade. The city grammar school principals showed a marked preference for physiology, eight voting "yes" and 14 "no" to question 1. Of the eight who replied to question 3, six were in favor of confining the work to the grades above the 5th. Of the whole number, 22, 72%, either did not answer the third question or would teach the subject in all grades. In answer to question 4, 10 of the 22 would first introduce a textbook above the 5th grade. Of the special teachers of physiology, seven would make of it a high school study, while one would confine it to college.

From the above it will be seen that the attitude of the city superintendents toward these questions does not differ widely from that of the whole group of teachers under consideration. That the grammar school men should favor physiology throughout the whole course to a greater degree than the other groups is a noteworthy fact. It would be interesting to know whether the preference is due to the change which a new subject gives to the routine of grammar school studies or whether the principal sees, in his closer relation to the pupils coming from all ranks of life, a greater usefulness in teaching pupils to abstain from tobacco and alcohol.

128, or nearly 63%, replied that the interest was diminished; 35 had noticed increased interest, and 13 more were doubtful. The reasons for diminished interest were not usually assigned. In 11 cases, weariness of the subject due to repetition was given as the cause; in three instances, disgust; and in nine the fault was laid on the teacher. One high school teacher of physiology preferred pupils who had not previously studied the subject to those who had; another said the pupils who studied in the high school alone passed the Regents examination in the same time and with as high marks as those who had taken the regular physiology work through the grades before entering the high school.

Question 6 What beneficial results do you observe in your school or community through the teaching of the effects of stimulants and narcotics?

To this question, 177 answers were given. Of this number 23 expressed doubt, 28 had seen beneficial results, and 120, or 62%, had noticed no effect whatever. The beneficial results were stated to be better habits or a healthy sentiment in favor of abstinence from the use of alcohol or tobacco. One principal said that not a single boy in his high school smoked or used alcoholic drinks. Five more gave a qualified answer, saying the results were beneficial under certain conditions. One was non-commital but said that the two breweries of his town were still doing business.

Question 7 Do you observe any detrimental results from the same cause?

132 answered "no" to this question, 13 gave instances where boys had experimented with tobacco or alcohol, either out of curiosity to learn its properties or a desire to "spite the teacher". It was believed that this action would not have been taken had not the study of the book suggested it. Another reason given by several was that the teaching in school was contrary to the child's own experience. "Many parents of children in my district", writes one ward principal, "drink moderately but regularly, and it is impossible to convince such pupils that

the use of alcoholic liquors is harmful". Waste of time, weariness on the part of pupil, disgust, loss of interest, false ideas regarding stimulants and narcotics, formed an aggregate of 18 additional cases where the results were considered bad.

Taken together, the answers to questions 6 and 7 do not show as marked results as might fairly be expected from a study which has been a compulsory part of the education of every school child in the state for five or more years. On the other hand, there is now no means of knowing how far or in what direction the teaching now in progress may affect the future character of the child.

The present system is based on the idea that, if the child knows what is bad for him physically, he will avoid it. The evidence shows that this is not always so. A prominent teacher writes: "A cigarette fiend won the last W. C. T. U. prize in our school for an essay showing the effects of tobacco. He still keeps on using cigarettes."

Question 8 What textbook do you use? Is it satisfactory? Why?

To this 113 answered "yes", 26 "fairly", 38 "no" and 18 "not entirely." The feeling expressed was in the main favorable, indicating that the book answered the purpose for which it was designed. "Satisfactory," "As good as the law allows," "Complies with the law," "Meets the Regents' requirements," are answers needing no comment. Some of the juvenile books were severely criticized. "Wishy-washy," "goody-goody" and "nothing in it" were descriptions applied by three out of five teachers using one particular series. Several objected to the treatment of stimulants and narcotics as given in the texts, and others said they could teach the subject better without a book.

Question 9 Do you look favorably or unfavorably on the use of highly colored pictures illustrating morbid physiologic conditions?

The answers to this were, "unfavorably," 126; "favorably," nine; favorably with qualifications, six. "They give exaggerated

and false impressions," "They create morbid tendencies," "Only normal types should be shown to children," "Sensational." "Unpsychological," "Vice is a monster," etc., express the general trend of opinion regarding this means of illustration.

Question 10 What changes, if any, would, in your opinion, improve the present system of teaching physiology?

The changes suggested showed a wide range of opinion. 12 teachers would leave the questions of quantity of matter and methods of presentation to the teacher, to the local authorities, to the Regents or to the superintendent of public instruction. 18 were in favor of putting the subject on the same basis as other studies. 52 would concentrate the time on fewer grades, making the work oral and hygienic below the sixth year. There was also a tendency in this group to emphasize hygiene and to do less with the topics of stimulants and narcotics.

2 A joint inquiry was conducted by F. N. Jewett and I. P. Bishop with the physiology classes in the Fredonia and Buffalo normal schools to ascertain if possible what the pupils had gained from previous study and what was their attitude toward the subject.[1]

The two classes aggregated 74 pupils, all above the age of 17. Their work includes both subject-matter and method of teaching.

Question 1 How many have studied physiology through the grades, or an equivalent amount, under the present state law? 50 had done so.

Question 2 How many have ever felt that they were getting too much physiology? None.

Question 3 How many have ever felt that they wanted more of the subject? 15 answered "yes".

Question 4 In how many cases has the interest in physiology been greater than the average interest felt in other subjects? Seven responded.

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[1]These questions were written out and read to the classes, all possible care being taken to avoid influencing the pupils' answers.

Question 5 In how many cases has the interest in this subject been less than the average interest felt in other subjects? 37 responded.

Question 6 How many can trace their aversion to the use of alcoholic drinks, or their disapproval of the same, to the teachings of the physiologies? None responded. (Much merriment in the Buffalo class)

Question 7 How many have ever known of others whose aversion to the use of alcoholic drinks was due to what they had learned of the subject from textbooks? One pupil knew of two cases occurring in the 9th grade of a certain school.

Question 8 How many have ever known of the correction of bad habits relative to the use of alcoholic drinks because of what was learned of their nature in school? None.

Question 9 How many have studied this subject where charts were used showing abnormal conditions of the organs? 22 had.

Question 10 In how many cases did the charts help to render the subject impressive? Two.

Question 11 Why did the charts fail so largely to impress the subject-matter? One said it was because some of the charts were not true, that their untruthfulness was recognized at the time. Another said that the children, inclusive of herself, were too young to understand the charts. A third said the charts were disgusting.

3 A third set of questions was sent out by J. E. Peabody to the physiology teachers in the high schools of the cities and larger towns of New York and New England. Copies of the paper were also sent to college and medical school professors and to prominent members of the Committee of 50. The circular was as follows:

1 The present state law prescribes that

The nature of alcoholic drinks and other narcotics and their effects on the human system shall be taught in connection with the various divisions of physiology and hygiene as thoroughly as are other branches in all schools under state control, or supported wholly or in part by public money of the state. All pupils . . . below the second year of the high school and above the third year of school work . . . shall be taught and shall study this subject every year with suitable textbooks in the hands of all pupils for not less than three lessons a week for 10 or more weeks. . . . For all students below high school grade such textbooks shall give

at least one fifth of their space, and for students of high school grade shall give not less than 20 pages, to the nature and effects of alcoholic drinks and other narcotics. This subject must be treated in the text-books in connection with the various divisions of physiology and hygiene, and pages on this subject in a separate chapter at the end of the book shall not be counted in determining the minimum.

Is it desirable to advocate any change in this state law? If so, what change should be made?

2 Should we emphasize, in teaching pupils, the difference between the effects of moderate and excessive use of alcohol?

3 If this distinction is made, shall we call the attention of boys and girls to descriptions of *delirium tremens*, hobnailed livers, etc.?

4 Authorities differ widely in respect to the effects of the *moderate* use of alcohol. Many of the most eminent physiologists claim this moderate use of alcohol is not injurious. In view of these facts, should pupils ever be taught that alcohol is always a poison?

5 Prof. Atwater's experiments seem to prove conclusively that alcohol in small quantity can be used like sugar, starch and fat for generating heat and muscular energy. Is it wise to describe these experiments to classes? (*See* Atwater's articles in *Harper's Monthly*, October and November 1900; *Outlook*, 1899. v. 62 and 63)

6 Statistics from the United States census in regard to pauperism, crime, insanity, and the cost of drunkenness are telling arguments against the present use (or abuse) of liquors in this country. Should these statistics be given in a course in physiology?

7 The rules of most corporations prohibit the use of intoxicants. Is it well to present to pupils this business argument for abstinence?

8 Please suggest the authorities that give the fairest view of the effects on the human body of alcohol and narcotics.

9 Shall we emphasize in teaching the difference in the effect of tobacco when used by youths and by adults?

10 What is the best form for our report, a series of categorical statements or a succession of quotations from authorities?

Nearly 100 replies were received, and the answers therein contained were tabulated.

In reply to question 1, relative to the state requirements concerning so called "scientific temperance instruction", only four expressed themselves as satisfied with the present law. Two others are in doubt as to the effect of the statute. All the rest condemn it either in part or *in toto*. The various grounds of dissatisfaction may be stated as follows:

a Too much time in the curriculum is assigned to the subject of alcohol and other narcotics. Many suggest that its consideration be omitted in several of the grades, stating that the weari-

some repetition required by law leads either to indifference on the part of the pupil or to actual hostility toward the subject.

b The pressure brought to bear on textbook writers, because of the law, makes most textbooks unbalanced in their proportions, if not, as is often the case, actually untruthful in their statements.

c The statute fails to accomplish what it was destined to accomplish, viz, the growth of an intelligent sentiment against the evils of intemperance. Teachers declare that the teaching of physiology and hygiene, which ought to be of great help in the every day life of the pupil, is becoming synonymous with teaching the effects of alcohol and narcotics; indeed in some schools the textbooks in the subject are called by the pupils "the liquor books."

After tabulating the answers to question 2 on the circulars returned, we find that the distinction between the effects of moderate and excessive use would be emphasized by three fourths of the writers. About two thirds of the papers say that the extreme effects of liquor in cases of *delirium tremens* and pathologic livers should not be portrayed in a course in physiology given to boys and girls. Only one third, on the other hand, recommend the presentation of Prof. Atwater's recent important experiments on alcohol as a possible source of energy. In answer to the question, "Should pupils ever be taught that alcohol is always a poison?" four fifths of the papers register a decided no.

Turning now from the physiologic aspect of the question to its moral and economic bearings, we find substantial agreement that perhaps the best arguments against intemperance are those furnished by the statistics of pauperism, crime, and insanity. Nearly all agree, too, that the business argument in favor of abstinence or strict temperance should be advanced, but several of the writers protest against introducing either of the arguments just named into a course in physiology and hygiene.

As already stated, your subcommittee has devoted most of its attention to the consideration of the alcohol question as

affecting the high school course. This was deemed advisable in view of the limitations of time. We believe, however, that the proper study of physiology in the elementary grades is of even greater importance, because of the practical teachings of hygiene that may be thus widely diffused. In this connection we are permitted to quote the following statement which will soon be published by a joint committee of the Teachers Association and Male Principals Association of New York city. This committee was appointed to recommend changes in the present New York city course of study.

The committee deplore especially the unwise and burdensome teaching of physiology foisted upon our curriculum by an arbitrary state law. We earnestly recommend that the teachers associations and school authorities of the city initiate some movement looking toward a more rational use of the time that is now devoted to so called "temperance physiology." This teaching is intended to give children an abhorrence of alcoholic drinks; but, by the unpedagogic methods it employs, it succeeds only in cultivating in children an abhorrence of the beautiful and useful science of physiology.

Conclusions of the committee from the preceding investigations

1 Physiology is the only subject in the curriculum that is dominated by legislative enactment. The result seems to be that instruction is commonly given in a perfunctory way, or that the provisions of the law regarding temperance instruction are disregarded. It should be remembered that no law, however stringent, can bring about effective teaching when the statements presented to the pupils are questioned or disbelieved by the teacher.[1]

2 The teaching of the effects of stimulants and narcotics under the present system has not produced any marked change of sentiment in the young either for or against their use. If any change exists, it is entirely disproportionate to the outlay of time and effort which has been made.

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[1]While we recognize the importance of legislation relating to the subject and acknowledge the great service which the members of the Woman's Christian Temperance Union have rendered in the cause of temperance instruction, your committee is of the opinion that our present law could be amended so as to be more acceptable to practical educators and to promise more satisfactory results.

3 Whether the matter taught is or is not excessive in amount, it is unwisely distributed through the course, and there is frequent and unnecessary repetition.

4 As the result, diminished interest and dislike of the subject prevail.

5 The preponderance of opinion expressed indicates that instruction could profitably be limited to fewer grades, those between the 5th and 8th being preferred.

6 The use of textbooks should not be made compulsory earlier than the 6th grade, if at all.

7 Though the textbook may not always be satisfactory, the teachers do not regard this fact as a marked impediment to their work.

8 Charts showing morbid physiologic conditions are generally condemned.

9 The evils of alcohol and narcotics can be presented most effectively from the moral and economic point of view.

Recommendations of the committee

1 The New York State Science Teachers Association should urge that the present law be modified in such a way that teachers of physiology be given more freedom to decide as to the character and content of their teaching, and writers of textbooks more freedom as to the space devoted to the subject and its location in the volume.

2 We are interested in the recent changes effected in the law in the state of Connecticut, and look with favor on its present provisions. But, before recommending similar specific changes in our law, we deem it wise to allow a reasonable time to elapse for observation of the working and results of that law.

3 So long as the existing statute remains in force, if truthful instruction is to be given in the subject, the possible benefits of alcohol when prescribed by physicians should be conceded. The difference in the effects on the human body of fermented beverages (beer and light wines) and distilled liquors should also be noted. Emphasis should be laid, too, on the greater

susceptibility of young persons both to direct injury from the use of alcohol in any form and to the danger of forming undesirable habits. Pupils should be allowed also to know that there is wide disagreement among authorities as to the physiologic effects of a strictly moderate use of liquors by adults. On the other hand, attention should be called to the fact that the moderate use of alcohol very commonly leads to excess, and the teacher should emphasize the fact that an immoderate use of liquors weakens the tissues so that they are made more susceptible to disease.

4 Finally, if the teacher wishes to present the strongest arguments in favor of either total abstinence or strict temperance, and thereby fulfil the spirit rather than the letter of the law, your committee recommends that comparatively little time be spent in trying to teach the physiologic effect of alcohol and tobacco. Let us frankly admit that we are discussing not so much a question of physiology as one of morals and economics, and let us devote the larger part of the time required by law to a treatment of the question from the moral and economic standpoint.

IRVING P. BISHOP
BURT G. WILDER
GAYLORD P. CLARKE[1]
ELI H. LONG
JAMES E. PEABODY
Committee

ALCOHOL PHYSIOLOGY IN THE PUBLIC SCHOOLS

BY PROF. W. O. ATWATER, WESLEYAN UNIVERSITY

Mr Chairman, ladies and gentlemen: The subject proposed for this afternoon is alcohol physiology in the public schools. Your committee have, however, asked me to repeat the substance of an address delivered before one or two other educational gatherings and, in so doing, to recapitulate briefly what I understand to be the outcome of the latest experimental inquiry

[1]Unable on account of illness to take part in the final work of the committee.

regarding the physiologic, and specially the nutritive, action of alcohol and to say something also about the kind and amount of instruction which should be required by state legislation and should be given in the schools.

If I may be excused for the indiscretion of giving the conclusions of my address at the beginning, they will be somewhat as follows. The amount of teaching of temperance physiology and the space given to it should be much less than are required by the legislation of a considerable number of states, including your own. The kind of teaching should be that which agrees most closely with the attested principles of physiologic science, that which is both scientifically and pedagogically most reasonable.

This, in my judgment, means a material modification of the legislation in many states, and an equally important change in the character of a large amount of the textbook instruction. These changes I believe to be called for in the interest of sound science, sound pedagogy, sound morals and effective temperance reform.

In this connection I am inclined to say a word in behalf of another subject. When we consider that "half the struggle for life is a struggle for food," that "half or more than half the earnings of the wage-earner is spent for the nourishment of himself and family," that not only a man's power to work but also his health, are largely affected by his food, that some of our most skilled hygienists are telling us that a large part of the disease which embitters life and hastens death is due to avoidable errors in diet, that more harm comes to the health of the community from erroneous habits of eating than from the habitual use of alcoholic drink, that economists, philanthropists and divines are urging more and more earnestly the need of attention to such subjects, are we not justified in asking if a little more room can not be found for it in the school curriculum; if some of the time and space now devoted to alcohol physiology might not be better given to food and nutrition in

But after this digression, let us come back to our subject. The purpose of all our instruction is to impart knowledge, provide mental discipline and build character. The temperance instruction has, in addition, a special purpose, namely, to promote moral reform. The so called "scientific temperance instruction" current in our schools seeks the latter purpose by impressing on our children the belief that science demonstrates that alcoholic beverages, even in very small quantities, are injurious to health. To enforce this teaching two means are adopted. One is the legislation which now requires the general subject to be taught in the public schools of all the states of the Union, I believe, save one. The other is found in the so called "approved" textbooks which put the special doctrine in the desired form. The same powerful agency which has secured this legislation—and the achievement is most noteworthy—has been able to influence and sometimes to control, in a large measure, the character of this instruction in the schools, by favoring the textbooks which have, and opposing those which have not its official approval.

I doubt if it is quite true, as the leaders of this great educational movement assert, that physiology as conformed to the doctrine of total abstinence is being taught to 16,000,000 children in the United States, because even the present combination of legislation and textbooks does not insure its being so taught in all schools; but the extent of the teaching is very great. The whole is accomplished by such diligence and such moral earnestness, that it has thus far been almost invincible.

Thus it comes about that we have in the United States a great educational movement which is attempting to build moral reform on a basis of scientific doctrine which the best scientific authority disapproves. Perhaps the matter has not occurred to you all in just this light before, but is not this a fair statement of the case?

A large and increasing number of men of science are coming to realize that scientific error has found its way into the curriculums of the schools and are earnestly considering what shall

be done to correct it. A lárge and increasing number of intelligent and conscientious teachers are coming to feel more and more deeply the harm which comes from what they consider to be false science and wrong pedagogic methods and are earnestly considering how they may be freed from the responsibility of the teaching, and how the children in their care may be freed from the harm that it brings.

We often hear the statement that nothing in the public education of our time has met with so general or so earnest disapproval from the best educators and most conscientious teachers as have the so called approved physiologies and the scientific temperance instruction. How true this is, I am not competent to judge. Certainly nothing I have ever known in any educational system has seemed to me to be so unanimously condemned by scientific specialists as a considerable part of the physiologic doctrine regarding the action of alcohol, which this instruction promotes. This is a strong statement. I should feel unwarranted in making it without adding another consideration, namely, that this same instruction has behind it an immense amount of earnest moral conviction. In every state of our Union, save one, are laws requiring temperance physiology in the public schools. This fact in itself is a remarkable phenomenon. It would have been impossible without an amount of conviction on the part of the best elements of the community which can hardly be overestimated. The movement has the support of a great body of people, profoundly interested in education and morals, tremendously earnest in their self-sacrificing efforts to promote temperance reform, convinced that the present teaching is called for and proper, and determined that it shall be enforced.

There is a clash between physiologists and teachers on the one hand and moral reformers on the other. Both are seeking the same object, the welfare of the children who are to be our successors, the building up of the public opinion of the future for the sake of the welfare of the future. On the main issue we are united; we differ as to the method. What is to be done about it?

The first need, I think, is that the public understand the situation. If the real import of this legislation, the kind of scientific doctrine it was intended to introduce, the conflict between that doctrine and what is commonly accepted by scientific authorities and is believed by wise and conscientious educators had been understood, I can hardly believe that the legislation could have become so general. Earnest reformers have seen a great physical and moral evil to be met and have believed that this was the way to meet it. All they have asked of the public has been an act on the statute book to require better instruction in the schools. This the legislatures have been led by public opinion to grant. I think the time has come for teachers to take up the question and show how the legislative and other influences have been utilized to force into our public school education an element which is scientifically, pedagogically, and ethically, most unfortunate.

I think it is safe to say that our present legislation has been introduced without a fair understanding of the facts. Its promoters have seen very clearly one side of the question, the awful harm which is wrought by alcohol. Wives and mothers, in thousands and in millions, feel with a force that outstrips all opposing argument the curse which drinking brings to homes, to hearts and to lives. Husbands and fathers, clergymen and philanthropists sympathize with them. Earnest men and women, impressed with this feeling, have believed, and honestly believed, the fundamental doctrine which the legislation is intended to enforce. They have said: "Let us see to it that the effects of alcohol are taught to our children. Let us fortify them against temptation. Let us provide for the temperance sentiment of the future by the education of the youth of the present." The appeal to the legislator has thus been backed by the moral sense of the community. There has been protest against the legislation, a protest rational and earnest, but unorganized and ineffectual.

The surprise with which many intelligent people receive the statement of the real facts which physiology teaches is, in

itself, an indication of the misunderstanding on which this legislation has been based and which the teaching has fostered. While I am in the fullest sympathy with the purpose and while I would not oppose all legislation of this kind, I believe, as I know many of you believe, that in its present form, the legislation is unfortunate and ought to be changed. I do not believe, however, that it will be changed till the subject comes to be clearly understood by the public at large. With that clear understanding of the real facts and principles, I believe that the public will demand that the laws on our statute books be made more rational, and I believe that the conservative and influential promoters of temperance reform will unite with educators in other states, as they have done in Connecticut, to secure such changes in our legislation and in our textbooks as will best conduce to the end which we all so earnestly desire.

The principle I wish to urge is this: if the alcohol physiology now being taught in our public schools as a branch of science is scientifically correct, then it can not be pedagogically or ethically wrong, and there is little reason for my discussing the subject today. But, if it does not tally with the most reliable conclusions from scientific observation and experiment, if what is taught as truth is half truth or partial truth, if doubtful theories are set forth as settled facts, if a rule of conduct is based on an unsound theory, if the attempt is made to improve the morals of the men of the future by a wrong teaching of the boys of today, that educational policy is pedagogically and ethically wrong and ought to be altered.

As teachers you know the current textbooks; may I invite your attention to the opinions of leading authorities regarding the physiologic and more specially the nutritive action of alcohol?

Opinions of leading authorities

The physiologic action of alcohol is very complex, and the views of physiologists generally regarding the different details are naturally divergent. Let us take, for instance, the much discussed question as to whether alcohol is food or poison.

First of all we must have a clear understanding of what we are talking about. A given substance taken into the body may act in a variety of ways. Meat, beefsteak for instance, which is universally called a food, supplies the body with material to build up its tissues, repair its wastes and furnish it with energy in the form of heat to keep it warm and muscular power for work. It also has an action on the nervous system which is not yet fully explained but may perhaps be called stimulative. Taken in excess, it may be injurious; its action is then pathologic. Being thus injurious, it might under these circumstances be called poisonous. Arsenic is sometimes taken as a medicine, and as such is believed to be useful, though we do not know exactly how or why it is so. But arsenic has no value whatever as nutriment and therefore can not be called in any sense a food. In more than minute doses it is deleterious or fatal. It is a true poison. There are certain vegetable products which, fed to animals, supply nourishment, but at the same time are injurious, so that they can not be used for food. Chemists have analyzed some such substances and found ingredients which are nutritious and others which are injurious. That is to say, some substances are clearly foods, some are clearly poisons, some act in both ways. How, then, shall we class alcohol? What I shall attempt to show you is that the results of the most valuable scientific research and the opinions of the leading physiologists of the world unite in saying that it may be either food or poison or both according to circumstances.

Alcohol is not like the meat or the seed, a complex material made up of different ingredients. It is a simple chemical substance. Nevertheless, it has very different actions. A chemist can analyze the seed and separate the parts which are nutritious from those which are poisonous. But he can not do this with alcohol. When the physiologist experiments on its action, he has to take it as a whole. This complicates the experimenting and makes the interpretation of the results difficult.

When we come to consider the dietetic use of alcohol, however, we must take into account not only its direct value for

nutriment but also its indirect action, as for instance, its effect on digestion. So likewise when we consider its pathologic effect, we must take into account its indirect action on the nervous system. Indeed, if we are going to study the subject at all thoroughly, we must recognize many subdivisions. Since we can not go into the details here, let me briefly summarize what appear to me to be the views of leading physiologists of the world. What do the authorities say in answer to the question, is alcohol food? Of course the answer depends first of all on the definition of food. But people may properly differ as to the definition, and it is not worth while to quibble about what may be left to the dictionaries. Let us then go back of this and ask, What do the specialists say as to its nutritive effect?

If we study the views held by the physiologists and pharmacologists in this country and in Europe, who are regarded by their fellow specialists as best qualified to speak with authority, we may perhaps divide them in three groups. At one extreme would be a small group who take grounds, more or less strongly, against any dietetic use or value of alcohol, but even this group would generally admit, I think, the absence of proof that alcohol does not supply the body with nutriment. There is a second group who are inclined to favor the moderate dietetic use of alcohol, tending to class it with nonproteid food materials, like sugar, starch and fat, but still maintaining that its classification as a food is not clearly established. And where they are inclined to question its value for directly supplying the body with nourishment, they maintain that it may be valuable as an aid to digestion and otherwise and find in this another reason for using it as part of the diet. A third group, whether they advocate or oppose its use, regard the evidence as sufficient to pronounce alcohol, in moderate quantities, a food in the sense that it may serve for nutriment, and many urge that there are circumstances in which its nutritive value is very important. Whether alcohol is or is not a poison, is likewise a question of definition. Here again wise men may disagree; but back of this lies the important question, is it injurious? That alcohol may

be injurious, that in large enough doses it is unquestionably a poison, and that in smaller quantities, taken habitually, it may be extremely harmful, there is no shadow of doubt. On this point there is no disagreement of authorities. But whether, or under what circumstances, it is injurious when taken in moderate quantities is a very different matter; and here opinions disagree.

The opinion of Prof. Fick, that alcohol in small amounts should be called poison, has been often quoted and is, I believe, made the principal basis of the statement in many of our school textbooks that alcohol is called a poison by the highest scientific authorities. But Prof. Fick defines poison in a way which, be it right or wrong, gives to the word a meaning quite different from that in which it is popularly used. He is one of the group of physiologists who practically deny any food value to alcohol. So far as I am aware, however, their number is small, and it is, I think, being reduced as the result of late research.

I have looked into many of the standard treatises on the subject and have conversed with many eminent physiologists, pharmacologists and chemists about it. In so doing, I have rarely seen or heard alcohol in small quantities called a poison, in the ordinary sense of the word, by any specialist who is generally regarded as an authority. Indeed, as I write this, I do not recall a single instance, but I should not feel warranted in saying that there are no such instances because they are things which one might forget, and furthermore, there may be many which I have not happened to see. I have no doubt that, if I had been looking specially for evidence on this side of the question, I might have found a good deal more than what I have just said implies.

To bring the various uses of food out more clearly, let me remind you that our foods contain different classes of nutritive materials or nutrients. One of these classes includes the nitrogenous substances, protein compounds or proteids, as chemists call them. The myosin which is the basis of lean meat, the albumen or white of egg, the casein which makes the curd of

milk, the gluten of wheat, are familiar examples of proteid compounds. They are transformed into blood, muscle, bone and brain. They are the true tissue formers of the body, the materials which serve for building the bodily machine and keeping it in repair. They also serve the body for fuel, but their use in this respect is limited. The fats, like fat of meat, the butter fat of milk, and the oil of cotton or of olive, make a second, and the carbohydrates, which include the starches and the sugars, a third class of nutrients of food. The fats and carbohydrates lack the chemical element, nitrogen, which is characteristic of the protein compounds, but they contain large proportions of carbon and are sometimes called the carbonaceous nutrients. By their oxidation, i. e. burning, in the body they yield its principal supply of energy.

Bread, meat, milk and the like contain both the nitrogenous and the carbonaceous materials. Meat lacks the carbohydrates; to make a well rounded diet, we use bread, potatoes and other vegetable materials with the meat. Bread and milk may be called complete foods, as they contain all three of these classes and with them the other ingredients necessary for nutrition. Such complete foods not only build the bodily machine and keep it in repair, but also supply it with fuel.

While proteids serve for building tissue and have a limited value for fuel, we could not well live on proteids alone. They are not complete foods. Fat, starch and sugars are not complete foods. They can not build tissue; nevertheless, they make the larger part of our food, for the reason that our bodies need more material for fuel than they do for building and repair.

Alcohol can not build tissue, it has no nitrogen. It can not be stored in the body for future use as is the case with fats, nor can it be transformed into fat and thus stored in the body as is the case with the sugars and starches. But it is oxidized in the body and does yield energy. In this respect it is analogous to the fats, sugars and starches. Just how it compares in fuel value with the fats, sugars and starches, or just how these compare with one another in fuel value are questions as yet unanswered.

Alcohol is, then, at best a partial food. To call it food, in the popular sense of the word, and without qualification, may produce a wrong impression. Furthermore, its action on the nerves and otherwise in the body, is such that only very small quantities can be taken without serious derangement. When taken habitually in excess, it is not only injurious to health but ruinous to character. And, while its nutritive action may be very important in some cases, specially with aged people or in certain forms of disease, people generally do not take it for the sake of its nutritive value at all.

Taking the word poison in the sense in which it is commonly understood, namely, as applying to substances which are deadly in their effect, alcohol in small quantities can not in my judgment properly be called a poison. It may be injurious in one case and not in another. Just where to draw the line between the quantity which may serve only as food and that which acts as poison is impossible. The amount that can be taken without injurious effect differs with different people. And, even though there are conditions in which it is not injurious and is even useful, yet there is the danger that it may lead to excess, a danger which, as teachers of youth, we must not, we dare not forget. This fact, coupled with the demoralization that comes with its habitual and excessive use, constitutes, in my judgment, the chief argument against its use.

But I have started to give you the opinions of leading physiologists and have indiscreetly gone out of the way to give you my own, and that, too, when I am only a physiologic chemist. Let us go back to the authorities. At the meeting of the International Physiological Congress, held in Cambridge, England, in September 1898, an effort was made to obtain an expression of opinion which might be taken as a consensus of leading physiologists regarding this special subject. The occasion had brought together some of the best known authorities from the different countries of Europe, America and even Africa and Asia. The congress did not include a great number of men, but it did include a number of great men. The following statement

which was drawn up by Prof. Michael Foster of the University of Cambridge, who was the president of the congress, was printed and offered for signature.

The physiological effects of alcohol, taken in a diluted form, in small doses, as indicated by the popular phrase "moderate use of alcohol", in spite of the continued study of past years, have not as yet been clearly and completely made out. Very much remains to be done, but, thus far, the results of careful experiments show that alcohol, so taken, is oxidized within the body and so supplies energy like common articles of food, and that it is physiologically incorrect to designate it as a poison, that is, a substance which can only do harm and never good to the body. Briefly, none of the exact results hitherto gained can be appealed to as contradicting, from a purely physiological point of view, the conclusions which some persons have drawn from their daily common experience that alcohol so used may be beneficial to their health.

I was present at the meeting and conversed with a number of the gentlemen present regarding the statement. Only a very few, so far as I heard, had any hesitation with regard to it. I learned of two or three who were unwilling to sign it without slight changes in the phraseology. I was told of one who said he believed it, but did not like to sign it, because it might be employed by liquor-sellers as an encouragement to their trade. There may have been a considerable number who disagreed with the statement in one way or another, but, if the number had been at all large, I think I should have known it. Certain it is that a very considerable number of the most celebrated men present expressed their decided approval in personal conversation. I have here a list of 62 men who expressed their approval by their signatures. Nearly all are well known investigators. Among them are professors, teachers and heads of laboratories of a large number of the most noted universities and medical schools of the world. The list includes many of the most celebrated physiologists of our time.

The following, also by Prof. Foster, is interesting, not only as a concise summary of what is definitely known about the physiologic action of alcohol, but also as showing how much space should, in the judgment of one of the most reputable of modern physiologists, be devoted to the subject in an elementary text-

book. It fills two of the 247 pages of the *Elementary Physiology* of Foster & Shore.

Alcoholic beverages. Ordinary alcohol is an organic compound of the composition of C_2H_6O. It occurs in the following proportions in the following beverages:

Beer	about	5	per cent
Light wines (claret, hock)	"	10 to 15	"
Strong wines (sherry, port)	"	20	"
Spirits	"	30 to 70	"

When alcohol is taken into the body, most of it is oxidized and gives rise to energy. The amount of energy thus supplied, compared with that of the other parts of the food, is insignificant, and the effect of alcohol depends not on the energy which it supplies, but on the influence it exerts on the changes going on in the several tissues. The value of the various articles of diet does not depend by any means solely on their ability to supply energy; we have seen, for instance, that salts which supply no energy are nevertheless of use in directing the changes going on in the body. In a somewhat similar way alcohol and other substances may influence and direct these changes. Whether that influence is beneficial or no will depend upon many circumstances, and certainly upon the quantity taken. We have many illustrations that a substance taken into the body in a certain quantity will produce one effect, and in another quantity it may be quite an opposite effect. There is no doubt that a certain quantity of alcohol is injurious and interferes with all the functions, and ultimately brings about various diseases, but it does not follow from this that in a smaller quantity it may not be harmless or even beneficial.

Alcohol produces its most marked effects on the vascular and nervous systems. It leads to a dilation of the small blood vessels of the skin, and so to a larger flow of blood to the surface of the body; this, while it produces a sensation of warmth, leads to an increased loss of heat by radiation and perspiration. If the amount of alcohol taken is excessive, the loss of heat will lead to a definite fall of temperature. Alcohol is then of no service as a preventative against cold.

Alcohol makes the heart beat more quickly and makes it do more work in a given time. In some cases this may be beneficial, but generally it is a wasteful and useless expenditure of energy. Alcohol diminishes the power of doing prolonged muscular work, and large quantities lead to a great diminution in the force of muscular contractions.

The effect of alcohol on digestion is very complex. When taken with food it leads to a diminution in the rate and completeness of digestion, if it is present in any but very small quantities. If some proteid (white of egg or fibrin) is put in a flask with some gastric juice, it is found that if a very little alcohol (1 part to 500 of the mixture) be added, the digestion will go on a trifle more rapidly, but if the alcohol added much exceeds the

amount, a well marked retardation is produced. It does not follow that such a small amount of alcohol is useful in ordinary digestion, because when it is taken into the stomach we have to consider the influence it has on the secretion of gastric juice, on the movements of the stomach, and on absorption. A small quantity of alcohol appears, however, to encourage the secretion of gastric juice, but large quantities act injuriously on all the processes of digestion.

A small amount of alcohol may promote the action of the central nervous system, and often appears to quicken the rapidity of thought and to excite the imagination, but more usually, and always when taken in any but small quantities, it diminishes the power of connected thought and judgment. It also diminishes the power of receiving sensory impressions, and at the same time blunts all the special senses. Since it reduces the sensibility to cold and fatigue and allays mental pain and worry, it is often resorted to, and then with great danger.

The limit up to which any beneficial effects are produced by alcohol is soon reached, and beyond that it only does harm. This limit is not the same for all individuals; a quantity good for one may be injurious for another, and a large number of people find that strictly moderate quantities of alcoholic beverages do them no harm, while others find that similar amounts impede them in their daily work.

The effect of alcoholic beverages does not depend solely on the ordinary alcohol in them, for other substances which they contain often have powerful actions in the body. The habitual use of such beverages to excess greatly shortens life by inducing diseases of many organs. In some cases of disease alcohol may be of great service, but in health it can not be considered a necessity, and is far more potent for evil than for good.

From the evidence at hand regarding the use of alcohol, the following, by Dr E. A. Parkes, the eminent English hygienist, seems to me a fair and judicious statement of the facts, though I should be inclined to lay a little more stress on the principle that, in health at any rate, it is superfluous or worse, and to insist more strongly on the importance, in this country specially, of general abstinence from its use.

The facts now stated make it difficult to avoid the conclusion that the dietetic value of alcohol has been much overrated. It does not appear to me possible at present to condemn alcohol altogether as an article of diet in health; or to prove that it is invariably hurtful, as some have attempted to do. It produces effects which are often useful in disease and sometimes desirable in health; but in health it is certainly not a necessity, and many persons are much better without it. As now used by mankind, it is infinitely more powerful for evil than for good; and, though it can hardly be imagined that its dietetic use will cease in our time, yet a clearer view of its effects must surely lead to a lessening of the excessive use which now prevails.

During the past 25 years I have been interested in this subject and have taken pains to read about it and to talk about it with many men who are recognized as the leading authorities in this country and in Europe. If I wished, I could easily select statements from a limited number of men that would conflict with the opinions thus expressed. But, if I try to get the consensus of opinions of the men who do the most of the experimenting and the observing, the men who have that habit of mind which is called scientific, the men who are considered by their fellow specialists the most reliable and the most authoritative, I hardly know how to express it better than in the language I have just read to you from Foster and from Parkes.

Reference has been made in the public prints to some experiments under my own direction at Wesleyan University which have had for their object the study of the nutritive action of alcohol. One does not like to say a great deal about one's own work, and I should rather stop with the references to what other investigators have done and said; but in view of the misstatements and misunderstandings which have received currency regarding these inquiries and the conclusions we have derived from them, it is perhaps fitting that I should refer to them now, as I have been specially requested to do.

The experiments in question have been undertaken in behalf of the Committee of 50 for the Investigation of the Liquor Problem, a body of gentlemen who have devoted themselves to inquiry regarding the action of alcohol. The committee is made up of business men, jurists, economists, sociologists, educators and divines, including some of the most prominent men in the country in their several callings. The committee have divided themselves up into subcommittees, and one of these subcommittees is that on physiology. The physiologic work has been divided among the individual members, and it happens that to myself was allotted the subject of the nutritive action of alcohol. The expense of the different inquiries has been borne mainly by private contribution, though sums have been received from certain trust funds devoted to scientific inquiries.

The experiments under my own direction have been materially facilitated by the use of laboratory privileges in Wesleyan University. They were carried out in connection with a series of researches on nutrition which are made under the auspices of the United States Department of Agriculture and constitute part of the larger inquiry into the economy of food, which is under my charge.[1]

The experiments are made by the use of the respiration calorimeter, by means of which it is possible to measure the income and outgo of the body of a man, as expressed in terms of both matter and energy. The apparatus includes a chamber about 7 feet long, 4 feet wide and $6\frac{1}{2}$ feet high, in which the man stays for a number of days and nights. It is furnished with folding bed, table and chair. For some of the experiments, those in which muscular work is to be done, there is provided a stationary bicycle, on which the man may ride the equivalent of a desired number of miles per day. Arrangements are provided for ventilation by a current of carefully purified air. The temperature is kept constantly at a degree which is agreeable to the occupant. In this chamber, he reads, writes, eats, drinks and sleeps. So far from being uncomfortable, each of the five gentlemen who have been subjects of the experiments thus far has found himself very little discommoded in any way save for the monotony of confinement in so small a space. The period of each experiment generally varies from four to nine days, though in one case it reached 12 days. Even after this experience not one of the gentlemen has been in the least unwilling to repeat the trial. So far from finding difficulty in securing subjects, we have numerous volunteers and are able to select men of special fitness for the purpose as regards both bodily characteristics and, where desired, scientific training.

[1]The results are given in detail in a memoir of the National Academy of Sciences, which is printed at the government printing office in Washington, and may be obtained by application to the secretary of the National Academy of Sciences, Washington D. C., or to members of Congress. A shorter account will be included in a report of the Committee of 50 on the physiological action of alcohol, soon to be published by Houghton, Mifflin & Co., Boston.

The special object of the experiments with alcohol was to study its nutritive effect as compared with that of the fuel ingredients, fat, sugar and starch, carbonaceous compounds, let us call them, of ordinary food. In most of the experiments pure (ethyl) alcohol was used, though in some the alcohol was given in the form of whisky or brandy. It was administered with water or coffee and taken with an ordinary diet of meat, bread, butter, milk, sugar, and the like. The amount of alcohol per day has been equal to about 2½ ounces of absolute alcohol—about as much as would be contained in three or four average glasses of whisky or in a bottle of claret or Rhine wine. This is generally divided in six doses, three with meals and three between meals, the object being to avoid any marked influence of the alcohol on the nerves and thus to test its action as food under normal bodily conditions. Comparative tests were made by use of rations with and without alcohol. The ration without alcohol consisted in each case of ordinary food materials supplying the nutritive ingredients in amounts more or less nearly sufficient to meet the wants of the body. In the corresponding ration with alcohol, part of the sugar, starch, and fat of the food, the carbonaceous ingredients which supply the body with fuel for warmth and work, was taken out, enough to be equivalent in potential energy to the two and one half ounces of alcohol, and the latter was used in their place. In the experiments in which the man did not work, this alcohol made about one fifth of the total material in the diet. In the experiments with hard muscular work, in which more food was used, the alcohol furnished about one seventh of the fuel supply. 13 experiments in which alcohol was used are now completed, and the results ready for publication. These are compared with a somewhat larger number of experiments similar in the main except that they were without alcohol.

The results will be best understood if we consider that alcohol is compared with the ordinary fuel ingredients of food—the fats, sugars and starches. These serve the body in several different ways. (1) They are oxidized in the body. (2) In the oxida-

tion their potential or latent energy becomes kinetic or active. (3) Part of this energy takes the form of heat, which keeps the body warm. (4) Part takes the form of muscular energy, with which the muscular work of the body is done. (5) In being oxidized the fats and carbohydrates of the food protect the fats of the body and of other foods from oxidation. (6) In like manner they protect protein from consumption. The question then is, Does alcohol serve the body as fuel in these several ways? We shall see later that the answer is in the affirmative.

Before going into the details, however, we may note certain differences between alcohol and the fats and carbohydrates. Some of these are the following. (7) The ordinary nutrients of food have to be digested. This is done by the action of ferments in the alimentary canal. Alcohol, on the other hand, requires no digestion; it is itself a product of fermentation, it is a predigested food. (8) The ordinary nutrients of food may be and commonly are stored in the body and kept for future use; alcohol can remain in the body but a short time without being oxidized. (9) Alcohol has various effects on the nervous system which are not exercised by ordinary food.

In considering the results of the experiments at Middletown we shall do well to take into account the outcome of other inquiry and thus arrive at conclusions of more general value.

In the very interesting report which was made by your committee and which voices the sentiment of a large number of excellent people to whom the questions were presented, I believe one of the questions was somthing like this: "Should the experiments of Prof. Atwater on the effects of alcohol be included in the instruction?" I understand that a minority answered in the affirmative. If I might be permitted to express my own view, it would be with the majority; I do not think that any particular set of experiments are worth putting into such instruction when there is so much of great importance in the way of conclusion.

What should and should not be taught about this subject in the schools

Will you permit me to state some of the things which, as it seems to me, ought and ought not to be taught in the public schools? In so doing I do not attempt to cover the whole ground or enter into the physiologic details, but simply indicate what, in my personal view, should be said or not said about some of the more important phases of the subject. Of the forms of its physiologic action I select two, its action as food and as poison.

What we should not teach about alcohol

1 We should not teach that it is a food in the sense in which that word is ordinarily used. If we are going to discuss its physiologic action at all, we can not well ignore its nutritive value, but we should at the same time emphasize its limitations. When we speak of it as food or nutriment we should explain to what extent and in what ways it can and can not nourish the body. So likewise, if we speak of its effect on digestion, we should not say simply that it is an aid or that it is a hindrance, but that it may be one or the other or both according to circumstances.

2 We should not teach that it is a poison in the sense in which that word is ordinarily used. We may say with truth that alcohol in large quantities is poisonous, that in large enough doses it is fatal, and that smaller quantities taken day after day will ruin body and mind. But it is wrong to teach our boys that alcohol in small quantities, or in dilute forms in which it occurs in such beverages as wine and beer, is a poison in the ordinary sense of the word. In all that we say on this subject we must bear in mind that the intelligent boy knows well, and as a man he will know better, that people have always been accustomed to moderate drinking as it is commonly called and yet live in excellent health to good old age. If we tell him that alcohol in small quantities is poisonous in the sense in which he understands the word, he will see that we are exaggerating, that we are teaching for effect, and he will instinctively rebel against the teaching.

We may say, and say truthfully, that the moderate use of alcohol is fraught with danger. But the cases where the occasional glass leads to marked excess are the exceptions. If we present them to the thoughtful boy as the rule or the common result, he will detect the fallacy and distrust the whole doctrine.

We may be right in saying that alcohol often does harm to health when people do not realize it, that it prepares the system for inroads of disease, that there is a gradation of injury from forms scarcely perceptible to the utter ruin of body and soul. But to present the "horrible examples" as a common result of drinking is illogical in itself, contrary to right temperance doctrine and hence injurious to the children whom we teach. For that matter I believe that the picturing of the frightful results of vice to young and innocent children is more harmful than useful.

3 We ought not to teach that alcohol in small quantities is harmless. Still more should we avoid saying that it is commonly beneficial. Some of us as individuals may believe that its use in small quantities is generally desirable, but there is nothing in either the facts of common experience or in the results of scientific inquiry to justify the inference as a general principle. Doubtless many people, specially those in advanced age, or suffering under certain forms of disease, are benefited by alcoholic beverages in moderate amounts. Here it may have a decided medicinal value, and my own belief coincides with that of a great body of physiologists in ascribing to it under some such circumstances an extremely important food value, though the exact ways in which it is useful are not yet demonstrated. But I can see no justification for the claim that moderate drinking is generally useful, and there is no denying the terrible fact that it is often harmful, not only in itself, but because of the excess to which it so often leads.

4 We ought not to teach that alcohol in small quantities is always or necessarily harmful. Some of us as individuals may believe this. Honestly believing that theory, we may be justified in arguing for it. But we are not justified in teaching it

dogmatically, and in my judgment, it is positively wrong to make such a dogma a part of the instruction which is presented to our youth as authoritative, be it in the school, the Sunday school or the pulpit. It is wrong for two reasons: first, because it presents an unproved theory as an attested fact; and second, because it leads the trusting child to believe what the thoughtful, and at times skeptical, boy or girl, and the intelligent man or woman may afterward learn to be wrong.

5 Still worse is it to take the theory that the use of alcohol in small quantities is always or necessarily injurious, and set it up as demonstrated by scientific observation and experiment. This is positive untruth. If we tell it to children, they will believe it till they learn better. They may possibly remain in ignorance of the error till they are grown or indeed all their lives. But sooner or later many of them will find that they were deceived; it may be in the high school, it may be in the college or medical school; it may be from general reading or conversation; but, when the deception is found out, a reaction comes. The good we tried to do is undone. The certain injury is far greater than the hoped for good.

To take the theory that alcohol is in no sense a food but always a poison, that it is never useful but always harmful, and allege that it is supported by the great bulk of scientific authority, is falsehood. We may look over the literature of the subject and cull out statements which can be used to support it. We may even find writers of more or less repute who attempt to defend it in the light of scientific experiment. In this way we may accumulate statements which the unsuspecting reader may be led to regard as proving that the scientific authority is on this side of the discussion. We may unconsciously go further and persuade ourselves that there is scientific ground for adopting such theories; so often and so truly is "the wish the father to the thought." In our great anxiety to find every means to work against the evil wrought by alcohol we may gradually come to feel ourselves justified in presenting all the arguments we can against it and in ignor-

ing all we can on the other side. But this does not turn theory into fact or falsehood or misrepresentation into truth.

Your committee have cited from so called "approved" text-books of physiology commonly used in our schools. The following quotations are of the same order:[1]

Alcoholic drinks greatly hinder the work of the stomach. They cause the pepsin in the gastric juice to precipitate or sink to the bottom instead of remaining dissolved as it ought in this important digestive fluid. The gastric juice, thus deprived of its pepsin, loses its power to dissolve the food, which therefore has to lie in the stomach until the glands can throw in enough new juice to destroy it. *Eclectic*, no. 2. p. 55.

Alcohol is universally ranked among poisons by physiologists, chemists, physicians, toxicologists, and all who have experimented, studied and written upon the subject, and who, therefore, best understand it.[2]

Alcohol is not a food or drink. Medical writers, without exception, class alcohol as a poison.[3]

It must be remembered that in whatever quantity, or wherever alcohol is found, its nature is the same. It is not only a poison but a narcotic poison.[4]

Beer is a fermented drink made from barley or other grain. . . The alcohol remains in the beer, making it a poisonous liquor. When the grape juice has been squeezed out and its sugar turned to alcohol, it is a poisonous drink.[5]

These statements are misrepresentations. They belong to a kind of doctrine which pervades many of the "approved" text-books and much of the common temperance instruction. They are none the less false or wrong, either scientifically or morally, because the object is to educate our youth away from evil; the misstatements are none the less reprehensible because they occur in school books which have the official indorsement of a great temperance organization, whose membership includes thousands and thousands of the noblest, the most conscientious, the worthiest, of the women of the world. Nor does it help the matter that such statements are repeated and such theories are promulgated with the sanction, and are enforced by the authority, of the church, in the teachings of the Sunday school and from the sacred desk.

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[1]See note at end of this paper.
[2]Quoted from Youmans in Blaisdell's no. 2. p. 232.
[3]Eclectic, no. 3. p. 57.
[4]Authorized Series, no. 3. p. 58.
[5]Authorized Physiology Series, no. 2. p. 45 and 49.

Do not misunderstand me. I am not imputing wrong motives, I bring no railing accusation, I charge no one with intended wrong. I only ask that the men and women who do these things—many of them are my acquaintances, some are my warm personal friends, their standing in the community is so high that no arrow of aspersion can reach them, their characters are so pure that no stain can tarnish them, their names are in my memory and their faces in my vision, as I write this—I ask, that they consider the facts as I am sure they have not considered them, that they look into the evidence as I am sure they have not looked into it, and that they remember in their attitude toward these questions the principle I have read in their own writings and heard from their own lips—the foundation of morality is the truth.[1]

What we should teach about alcohol

1 It is, under some circumstances, a valuable nutriment in the sense that it can yield energy to the body but not in the sense that it can build tissue. It is, under other circumstances, a poison in the sense that it is injurious to health. When taken in large enough quantities and for long enough time, it is destructive to life. It is sometimes very useful and sometimes very harmful, but the harm that comes from drinking, in many communities, vastly exceeds the good.

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[1]A number of years ago, a representative of a large publishing house said to me: "We publish school books. To make our business successful, we must have a good assortment of books. In order to sell the arithmetic and grammar, we must have a physiology also. In order to sell the physiology, it must be 'approved.' To secure the approval we must put a lot of stuff into it which is not true. Generally speaking, we consider it to be our business to make books and sell them, and leave the responsibility for the contents to the authors. But, when it comes to school books, we can not get rid of the responsibility and we can not sell the physiology without doing an amount of lying of which we are heartily ashamed."

We can well appreciate a remark which the author of a popular series of school physiologies made to Prof. Bowditch of the Harvard medical board. When asked how he could justify the unscientific statements, the author replied with warmth, "I have studied physiology, and I do not wish you to suppose that I have fallen so low as to believe all the things I have to put into those books."

I have conversed with not a few publishers and authors of school physiologies, and they all say the same thing. The story is a sad one.

While we can not deny to alcohol a nutritive value, that value is very limited. In yielding energy to the body it resembles sugar, starch and fat, though just how and to what extent it resembles them experimental inquiry has not yet told us. It differs from them in that it does not require digestion and is hence believed to be more easily and immediately available to the body. It is not stored in the body for future use like the nutrients of ordinary food materials. The quantity that may be advantageously used is small. If large amounts are taken its influence on the nerves and brain are such as to counteract its nutritive effect and it becomes injurious in various ways. And finally there are many people who begin by moderate use and are led to disastrous excess.

Alcohol may be useful to one man and harmful to another. One may take considerable without apparent harm, while another may be injured by very little. One may use it habitually without injury, while another may not. In sickness it may be a priceless boon. But it may likewise be the cause of physical, mental, and moral ruin.

2 The boy or the man, as long as he is in good health and does not need alcohol for medicine, is in general better off without it.

3 While some can drink a little without danger of drinking to great excess, others can not. The safest way is to keep out of danger.

4 There are business considerations, also, as well as those of health that strongly favor temperance. The boy who wants to make his way on a railroad or in a large business establishment, has a better chance to get employment and to work up into a profitable position if he is an abstainer than if he is a drinker. Already many such establishments refuse to employ men who drink and there is reason to expect that more will do so.

5 Temperance is always advisable. This we may emphasize most strongly. But whether or not we shall teach the necessity or even the advisability of abstinence is another matter. About this the best men differ. Two who disagree may be

equally honest. Each has the right to express his own convictions and may often feel it his duty to do so. But it is neither just nor wise to teach our youth that the doctrine of total abstinence rests on undisputed principles of either physiology or morals. It seems to me that the question whether a man should be a total abstainer depends on two considerations. The first is one of policy. Will drinking injure him? If so, he had better abstain; if not, he may drink. But he should be sure of his ground before he begins, and he had better wait till he reaches maturity and understands himself and the subject well, before he takes the risk. The other consideration is an ethical one. Paul's doctrine of refraining from that which will cause others to offend is a rational and forceful appeal to conscience. Remembering that a man does not live for himself alone, what will be the effect of his example and what is his duty? The rule of conduct in this respect, is a matter for him to decide. You and I may have the right to advise him, but the decision is between himself and his own conscience.

6 An ambitious and right-minded boy wants to be an influential and useful man. I think he should be taught that it would be better for the community at large if there were less drinking; that the community are influenced by the examples of strong and good men; and that his own personal influence will be better if it is on the side of temperance.

7 Great as is the danger of alcohol to purse and health, the moral injury is incomparably worse. Its most terrible effect is its demoralization of character. However much good men may do in helping others to save their money and promote their health, a still greater service to their fellow men is that which helps them to a higher plane of moral living. And here is the strongest argument of all in favor of that self-abnegation which leads us to do those things, and those things only, which will best enable us to render that service to our day and generation. In that way we do our noblest duty to our fellow men and to our God. All this we may and I believe we should teach in the schools.

Errors in the current temperance teaching. Ethical considerations

The misstatements in the textbooks of the type referred to above are of various kinds. Sometimes the error consists in stating doubtful theories as attested facts; in other cases, the principles laid down are partly true and partly false; in still others, the statements are squarely opposed to the results of all of the latest and most accurate scientific research. The statements are enforced by quotations, of which some are by real authorities but are too often put in such ways as to misrepresent their actual teachings, while others are from men who do not stand for the best research and the highest scholarship but are quoted as the most reliable authorities.

I do not mean that the approved textbooks are all wrong. A great deal of what they say is entirely true. In the parts not bearing on the action of alcohol there is often little to criticize and much to commend. The trouble is this admixture of error.

In one respect they are all alike. The impression which they give the pupil is that science teaches that alcohol, even in moderate quantities, is always harmful and never useful. This is untrue.

The object is to oppose an enormous evil, to teach our youth to resist that evil. The purpose is most worthy; the trouble is in the method. The evil being clearly defined, a doctrine is formed to meet it, and evidence is sought to sustain the doctrine. Whatever can be found in its support is exaggerated. Whatever opposes it is ignored or denied. It gradually ceases to be the propagandism of the few and becomes the creed of the many. It is the old story of human dogma, repeated over and over again in politics, in theology, and in morals. And here, as in many other cases, the worthiness of the cause and the earnestness of the advocates are such as often to "deceive the very elect." Indeed, the very best people often become the most sincere and devoted advocates of the doctrine. In this case, the scientific expert is not deceived. But the statements are put in such persuasive ways and sustained by such seeming force of scientific authority that the unsuspecting pupil, and indeed

the teacher who implicitly trusts the textbooks, is led to believe that they represent the real teaching of the best physiological science.[1]

I was once talking about this subject with a teacher and reminded her of Lincoln's saying: "You can fool all the people some of the time, and some of the people all the time, but you can't fool all the people all the time." She replied: "But can't we fool the boys till their characters are formed?" Now I think that lady was perfectly sincere; I am equally sure that she was wrong. You can not build character on falsehood.

A well known philanthropist in New York city tells this story: "I happened to be in a school down on the East side when a class of boys from tenement families were reciting in physiology. The teacher asked, 'What is beer?' The answer came in chorus, 'Beer is poison.' Now those little chaps knew that

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[1]An honored teacher whom you well know, Samuel T. Dutton, formerly of Brookline Mass., now of New York, in discussing this subject, speaks as follows:

> From the point of view of temperance, sound education and good morals, I am sure that this condition of affairs calls for our strong disapproval. We do not teach hygiene by the study of disease, cleanliness by the observation of filth, purity by the contemplation of vice; and to force upon every child 100 lessons or 500 lessons on the effects of alcohol is likely to take away his sensitiveness and to make him morbid or indifferent, if it does not bring about a reaction which leads him to say: "I am going to try it." Children who are taught that wine and tobacco are absolute poisons, and who see their fathers, brothers and friends constantly indulging in these stimulants, can only look with ridicule and contempt on this effort to deceive and frighten them. It is certain that the teachers who have tried conscientiously to give this instruction have often seriously questioned whether they are not justified in evading the requirements of the law in order to avoid the greater evils which were likely to follow the teaching.

I wish to emphasize what seems to me the unwisdom of this kind of teaching for young children, to which Mr Dutton has so aptly referred. It is argued that a great majority of the youth leave school early and the only opportunity to teach them anything about this most important subject is in the lower grades. Since they can be taught but very little, the instruction is confined mainly to one thing, namely, the principle that physiologic science shows that alcohol is always harmful to health. Even if this were true, it seems to me doubtful whether the teaching could have the desired effect, whether the harm that comes from the revealing of evil to children is not greater than the good. But, considering how much untruth there is in the doctrine, must it not in the long run be positively harmful?

that was a lie. Their fathers and mothers drank beer every day. Such children were not fooled by any such teaching."

But even if they are deceived for a time, it will not last, nor can you get around the difficulty by falling back on definitions. Tell a boy a thing is poison, and he will suppose that you mean by poison what he means by it, and what people generally mean by it. He has not access to the particular dictionary or scientific treatise which has a definition that may be stretched to fit your meaning. You may persuade him for a time that it is a poison in the popular sense of the word, but, when he grows up, he will learn that he was mistaught; indeed, he may do so before he is grown up. Scholars in the higher classes share the present tendency to skepticism; when the pupil finds that he was deceived, he does not mince matters, he reasons with himself, "That teacher and that textbook lied. If they would lie in one case, they would in another, and I am not going to believe anything they told me." Even if he does not go so far as this, even if his faith is not lost but is only shaken, the harm is done; the effect is to undo much of the good that the teaching is intended to do. Furthermore, and what is still worse, the result must be to impress on the pupil, and by the most effective agency, that of example, the example of the school, the Sunday school and even the pulpit, the idea that deception is allowable in a good cause, that the end justifies the means. This is undermining the very foundations of morality.

One of the most honored school superintendents in the United States remarked to me in speaking of this subject: "Teach the boy of 10 that a lie is the truth, and at 20 he is in danger of believing the truth is a lie."

This evil, so intrenched behind the earnest aspirations of our community, and so fortified by legislation, is the one against which I protest and which I urge you, as leaders in education, to unite in your endeavors to oppose.

Perhaps I ought to speak more considerately of things so dear to thousands of the best, the most earnest, the most devoted people, those to whom temperance means so much, who

would shrink with horror from intentional deceit and in the fiber of whose noblest thought this doctrine is so interwoven. We meet here a very peculiar difficulty. The object of this teaching is a noble one. When we criticize the method, we are in danger of seeming to oppose the purpose, and yet the improvement in method is necessary for the attainment of that purpose. It seems to me that one of the great obstacles in the way of the true temperance reform is found in this very exaggeration which makes so large a part of the means used to promote that reform. It is building on the sand. The place to build is on the rock of attested truth.

You see then, that I am not trying to set up a dogma in opposition to "scientific temperance instruction." I earnestly approve of the purpose but object to part of the method. I protest against the dogmatic teaching of scientific theories which still lack demonstrative proof. More than that, I protest against the teaching of what science shows to be positively erroneous. And I also ask that the teaching of science in our schools shall keep pace with the progress of research.

But what are we to do about it? I hesitate to make positive suggestions to those who have much more experience than I and on whom rests so much of grave responsibility for deciding what instruction our youth shall receive. I venture, however, these considerations.

The success of such instruction depends very largely on its spirit. If it is based on the real desire for truth, if disputed principles are referred to as questions rather than demonstrated facts, if no more is claimed than is proved, and if, under these restrictions, the evils of alcohol are clearly set forth, and specially if the teacher speaks with the power of accurate knowledge and profound conviction, the instruction can not fail to be incalculably useful.

Still more effective will it be, in my judgment, if less stress is laid on the material, i. e., the physiologic and economic side of the question, and more on its moral aspects. Our people are keenly alive to ethical ideas. And youth is a time when thought

is fresh, the aspiration is for the ideal, and mind and heart are open to the truest ethical impulses. Let me emphasize most strongly the moral aspects of this question. Temperance reform is moral reform. I can not see how a thoughtful man, earnestly desirous of rendering his best service to the community, can fail to be interested in that reform. The harm which alcohol does to health, the economic injury it brings to the individual and to the community are terrible enough, but it seems to me that the supreme evil which comes from its misuse is its effect on character, its power of demoralization, the moral ruin which it brings. No exaggeration is needed to paint this picture in the most terrible colors. As one who has been interested in temperance reform from childhood, I have come to believe that we have been depending too much on the economic and physiologic argument. Statistics of the nation's liquor bill do not appeal very strongly to the ordinary man, still less does the average boy care for them. The men who know most about the physiologic effects of alcohol are specialists in physiology and hygiene. I know scores of these men. Total abstainers among them are exceptions, I was about to say, rare exceptions. The same, we all know, is true of practising physicians. If they are not persuaded by the facts they know so well in both theory and practice, what can we expect from teaching the average boy or girl a little of the theory?

The supreme object of education is the formation of character. Character is shaped by education, but its basis is morality. Again I say, temperance reform is moral reform. The mind and heart of youth are most strongly influenced by mortal thoughts, by ethical ideals. There you can keep within the truth and there make the strongest appeals.

I am speaking to you as teachers, about a principle of pedagogics. Will it seem inappropriate if I refer to the example of the greatest of all teachers, One whose doctrine is so profoundly wise that its wisdom is the more highly appreciated as the individual and the race constantly increase in knowledge and experience? The foundation of His whole doctrine was simple

truth. He appealed always and solely to what is best in us; least to the lower and more material considerations and most to the higher ethical aspirations. Above all things, He avoided the basing of rules for conduct on material arguments about which there could be any special doubt. That teaching is understood by the child, its power over him grows with his growth, it becomes a controlling force in his life. I do not say that material arguments can not be effective, nor do I wish to minimize their usefulness. What I do urge is that they can not be useful at all unless they are so true as to be beyond question, and that, at best, they do not constitute the most effective appeal. Tell the child that the reason why he should not drink is because alcohol is always poisonous, enlarge on the harm it does to health, and you may produce a strong impression, but the danger is that it will not be lasting. The seed falls where there is not depth of earth; and, with the on-coming of mature knowledge and the understanding that the principle is wrong, it withers away. Plant where there is depth of earth, where the roots will strike down into the depths of moral conviction, and it will bear fruit many fold.

Those things are most influential and useful in education which draw out what is best in the learner, which cultivate the germs of conviction and aspiration in his own soul, so that they grow up into purpose, character and influence. What we say, the child forgets. The rules are written on the memory, but time effaces them. The things which remain are the impressions which sink down, become a part of feeling and judgment and then grow up again into permanent character. The impressions that are lasting and useful are the ones that accord with the deepest and truest convictions, and the ones that the experience of age can verify. These are what develop the power within us that makes for righteousness.

One essential for the success of true temperance reform is that what is taught as science shall be placed on the basis of demonstrated fact. This means a change of base on the part of a great body of our most earnest temperance reformers; but

that change is necessary. We wish to help the drunkard to reform; but is it necessary to tell him that no man can touch alcohol without danger? To build up the public sentiment on which the reform of the future must depend, we wish our children to understand about alcohol and its terrible effects; but, when we teach them in the name of science, shall we not teach them the simple facts which science attests and which they can hereafter believe, rather than exaggerated theories, whose errors, when they learn them, will tend to undo the good we strive to do? In short, is not temperance advisable even in the teaching of temperance doctrine?

In the great effort to make man better, there is one thing that we must always seek, one thing we need never fear—the truth.

Conclusion as to alcohol physiology in the schools and legislation requiring it

To come back to the original question: my own answer will be somewhat like this.

The amount of time and space that should be given to the physiologic action of alcohol in our school books and schools should be limited. I should say that a small number of pages, enough to correspond to only a very few daily lessons, would be ample, and that this should be taught only in the higher and not in the lower grades.

The kind of instruction should be that which is scientifically correct. Above all it should be based on plain, well attested, impartial, unexaggerated fact. The chief argument against the use of alcohol should rest on the ethical rather than on the physiologic or economic basis.

The legislation which requires this instruction should be general rather than specific. Both the kind and the amount of instruction should be left to the great body of capable, conservative, and earnest educators to decide.

The Connecticut school physiology law

Many of you are aware that the Connecticut legislature last winter repealed the somewhat stringent statute regarding the teaching of alcohol physiology in the public schools which has been in force since 1893, and put in its place a law which is much more acceptable to the teachers of the state as well as to educators and men of science generally. If you are not already familiar with the details, you may be interested to know how the movement came about and what is the nature of the new law. In Connecticut, as elsewhere, there has been great dissatisfaction among teachers and others with the requirements of the statute and with the "approved" textbooks which have been practically forced on the schools. At a meeting of our State Council of Education just about a year ago, a paper was presented on this subject. Indeed, I might just as well say frankly that it was very nearly the same as that I have been presenting to you today. It was naturally followed by some rather active discussion. The topic had been announced in advance and several leaders of the temperance organizations of the state were present by invitation. A bill had already been brought before the legislature, providing for a repeal of all requirements for temperance instruction. The feeling of educators was quite strong; some favored the bill doing away with the temperance physiology entirely, but the majority thought it best to retain some features of the instruction. The secretary of the state temperance society, realizing the state of affairs, suggested that the school people and the temperance people should get together and endeavor to come to some agreement, and, if it seemed best, ask for modifications of the statute then in force. The suggestion was accepted and a committee of principals and superintendents was appointed for the purpose. The outcome was that the temperance organizations, including the state branch of the Woman's Christian Temperance Union, gave their assent to a bill proposed by the teachers' committee and agreed to support it before the legislature. The bill was

introduced in the legislature and warmly urged. Some of the teachers, indeed, felt that it would be better to do away with all legal requirements for temperance instruction, but they withheld opposition as did many of the temperance people, who felt that the new bill surrendered what they had earnestly and conscientiously striven for. A few of the more strongly partizan temperance people in the state objected to it. The strongest opposition, however, and it was at once viligant, systematic and intense, came from the national organization of the Woman's Christian Temperance Union through its department of scientific temperance instruction. On the other hand, the bill was warmly approved by such educators as Pres. Hadley of Yale, Pres. Raymond of Wesleyan and a number of the scientific men of the state. When the bill came to actual vote in the legislature, it passed without a word of opposition.

An incident in the campaign is worthy of mention. It arose from the division in the ranks of the Woman's Christian Temperance Union. The state branch had pledged itself to the support of the bill. The national organization endeavored to induce individual members and organizations in the state to withdraw their support and oppose it. The state president, however, was true to the pledge and was able to influence most of her associates in the state to be true also.

Indeed, it was evident to the temperance people that this was the part of wisdom. They saw the danger that all they had accomplished by way of legislation would be done away with. They had also learned that not even state legislation could be depended on to enforce instruction which was opposed to the reason and conscience of the teachers and the best pedagogic and scientific opinion.

The new law is a compromise. While it does away with much that the temperance people earnestly desired, it still goes further in its requirements than many of the teachers would have wished. But it has the great advantage that it leaves the character and amount of instruction in alcohol physiology to the good judgment of the teacher. It requires that (1) the effects

of alcohol and narcotics on health and specially on character shall be taught in connection with hygiene as a regular branch of study to all pupils above the third grade, except in public high schools, that (2) suitable textbooks of physiology and hygiene, which explain the effects of alcohol and narcotics on the human system, shall be used in grades above the fifth, except in public high schools, and that (3) all normal schools and teachers training classes shall give instruction in this subject and in the best methods of teaching it. It does away with the old requirement for teaching it below the fourth grade, because of the belief that little children are better off without it. It does away with the requirement for teaching it in the high schools, on the theory that physiology should be taught there like other branches of science. It leaves the kind and amount of teaching, as well as the kind of textbook and the amount of alcohol physiology it shall contain, to the decision of school boards and teachers, on the supposition that they can best judge what will be most useful to be taught to the children in their charge.

The chairman of the teachers' committee, W. B. Ferguson of Middletown, says very aptly that this is the first instance on record of the temperance people and teachers of any state uniting in the support of a measure of this kind. He adds:

> Too much praise can not be given those broad-minded, sensible, and courageous temperance people of Connecticut who showed an open mindedness, a spirit of conciliation, an invincible loyalty to their agreement under circumstances that would have severely tested the courage and faithfulness of any but those who place duty before policy, honor before favor, and the interests of the children before the pleasure or censure of anybody.
>
> It now remains for the school officials and teachers of the state to live up to the letter and spirit of the law by endeavoring to impress on their children and youth the principles of temperance and of temperate living.

Our act of 1893, which this new one of 1901 replaces, was less stringent, less burdensome to teachers, and, in my judgment, less detrimental to the interests of the schools and of temperance than your present legislation in New York. In our case the change was rendered possible by a discussion in which the

public was made aware of the actual nature and tendency of the law and of the instruction it required, and of the attitude of teachers and others regarding it. The conflict between the so called "scientific temperance instruction" and the convictions of educators and men of science was thus made clear. The more conservative temperance leaders met the teachers half way. Thus united, they took counsel with each other and with educational and scientific authorities, agreed on a measure, saw it through the legislature despite the opposition of the more radical elements, and are determined to do their best to make the teaching effective for the purpose for which it is really intended. This seems to me a very happy solution of what otherwise might have been a very serious difficulty.

I venture to inquire whether you may not be able to bring about a similar cooperation of conservative friends of temperance reform in your own state.

[Prof. Atwater referred to a statement quoted by the committee from Steele's *Hygienic Physiology* as an illustration of the teaching that alcohol is not oxidized in the body and, on this account, can not serve for nourishment. He stated that this passage occurs in the latest edition he had been able to obtain from the publishers, one or two years ago, and that it contained an indorsement by the scientific department of the Woman's Christian Temperance Union, certifying that the statements in the book had been carefully revised so as to keep abreast with the latest teachings of science. This statement was, according to his recollection, dated in 1889. As Mrs Hunt, the superintendent of the scientific department referred to, was present, he asked that she would kindly correct his statement if it was in any respect erroneous. Mrs Hunt replied as follows:]

Mrs Mary H. Hunt—*Mr Chairman:* I understand Prof. Atwater to charge that the *Hygienic Physiology* by J. Dorman Steele, was not abreast with the teachings of science on the subject of the oxidation of alcohol in the human body at the time indorsement to it was given.

To this I reply, the facts do not sustain this charge. The book, Steele's *Hygienic Physiology*, was written in 1884, though no formal indorsement was given to it till 1889. At that time, 1889, men of eminence, students of the alcohol question, like Dr N. S. Davis, of Chicago, and Ezra M. Hunt M. D., of Trenton N. J., said that the oxidation of alcohol could not be admitted till the products of such oxidation were found. The latter, Dr Hunt, in his paper on "Alcohol as a Food and Medicine" read at the International Medical Congress at Philadelphia, quoted a then recent edition of Wood's *Materia Medica* which said: "No one has been able to detect in the blood any of the ordinary products of its (alcohol's) oxidation." Consequently the book, in not affirming that alcohol is oxidized in the system, represented a respectable school of medical opinion at the time the indorsement to it was given.

In 1890 Bunge's *Textbook of Physiological Chemistry* appeared, which said: "We know that alcohol is to a very great extent oxidized in the body". "But," he adds, "it does not follow that it is therefore a food." From this it is clear that up to 1890 there was good authority for not teaching that alcohol is oxidized in the body.

In 1897 Dr Koppe, in a paper read at the International Medical Congress at Moscow, said that oxidation did not prove a substance a food, that morphine, as was well known, is oxidized in the body, but no one thinks of calling it therefore a food. Other scientists have said the same thing.

Inasmuch, therefore, as oxidation does not settle the question of the food value of alcohol one way or the other, and inasmuch as the book did not state that alcohol is not oxidized in the body, there was no imperative call for immediate change. Nevertheless, a revision of the book in this and other particulars, delayed somewhat by the fact that the author had died, has been on the market for some time.

Mr Chairman, I submit that it is most unjustifiable to cite the statements of an old edition of a book that was abreast with science at the time it was written and is now revised to date

as evidence of the inaccuracy of the teaching for which the temperance education movement is responsible.

[The textbook referred to is Steele's *Hygienic Physiology*, which bears the following indorsement:

Boston, June 20, 1889

The Pathfinder Series of Textbooks on Anatomy, Physiology and Hygiene consists of the following volumes:

1 Child's Health Primer (for primary grades)

2 Hygiene for Young People;
 or Young People's Physiology (for intermediate classes)

3 Hygienic Physiology (for advanced pupils)

The above are the series originally prepared (as their general title indicates) to supply the demand created by the laws for temperance instruction in public schools in the United States.. They were written by experts under the supervision of the scientific department of the National Woman's Christian Temperance Union, published by the instigation of the same, and have been carefully revised from time to time, under the same supervision, to keep them abreast with the latest teachings of science.

Being both teachable and well adapted to grade, their educational value, as proven by school room tests, is of the highest order. We therefore cordially indorse and highly recommend the Pathfinder Series for use in schools.

Mary H. Hunt

National and international superintendent of the scientific dep't of the Woman's Christian Temperance Union; life director of the National Educational Association

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In the *School Physiology Journal*, edited by Mrs Hunt, several series of approved physiologies have long been advertised. The Pathfinder Series, to which Steele's *Hygienic Physiology* belongs, was placed first in the list of those recommended in the advertisement as late as September 1900. In October 1900 the New Century Series was announced, but the Pathfinder Series was still continued, though it does not appear in the latest numbers of that journal.

The passage referred to by Prof. Atwater was the following from pages 177-79 of the textbook named:

Is alcohol a food? To answer this question, let us make a comparison. If you receive into your stomach a piece of bread or beef, nature welcomes

its presence. The juices of the system at once take hold of it, dissolve it and transform it for the uses of the body. A million tiny fingers (lacteals and veins) reach out to grasp it, work it over, and carry it into the circulation. The blood bears it onward wherever it is needed to mend or to build "the house you live in." Soon, it is no longer bread or beef; it is flesh on your arm; its chemical energy is imparted to you, and it becomes your strength.

If, on the other hand, you take into your stomach a little alcohol, it receives no such welcome. Nature treats it as a poison, and seeks to rid herself of the intruder as soon as possible. The juices of the system will flow from every pore to dilute and weaken it, and to prevent its shriveling up the delicate membranes with which it comes in contact. The veins will take it up and bear it rapidly through the system. Every organ of elimination, all the scavengers of the body—the lungs, the kidneys, the perspiration glands, at once set to work to throw off the enemy. So surely is this the case, that the breath of a person who has drunk only a single glass of the lightest beer will betray the fact.

The alcohol thus eliminated is entirely unchanged. Nature apparently makes no effort to appropriate it. It courses everywhere through the circulation, and into the great organs, with all its properties unmodified.

Alcohol, then, is not, like bread or beef, taken hold of, broken up by the mysterious process of digestion, and used by the body. "It can not therefore be regarded as an aliment", or food. *Flint*

To the above clear statement that the alcohol, instead of being burned in the body, is eliminated without change, is added the following statement in a footnote, which represents the oxidation of alcohol as a disproved theory.

Because of the difficulties of such an experiment, we have not yet been able to account satisfactorily by the excretions for all the alcohol taken into the stomach. This remains as yet one of the unsolved problems of physiological chemistry. To collect the whole of the insensible perspiration, for example, is well-nigh impossible. It was supposed at one time that a part of the alcohol is oxidized—i. e., burned, in the system. But such a process would impart heat, and it is now proved that alcohol cools, instead of warms, the blood. Moreover, the closest analysis fails to detect in the circulation any trace of the products of alcoholic combustion, such as aldehydes and acetic acid. "The fact", says Flint, "that alcohol is always eliminated, even when drunk in minute quantity, and that its elimination continues for a considerable time, gradually diminishing, renders it probable that all that is taken into the body is removed."

[Referring to the above statement Prof. Atwater said:]

The difficulty of collecting the whole of the bodily excreta, including the "insensible perspiration" was solved by Petten-

kofer and Voit with the respiration apparatus as early as 1862. In 1883 Bodländer measured the alcohol excreted by a dog through the lungs, the skin and the kidneys separately and found that under ordinary circumstances, at least 95% was oxidized in the body.

To recapitulate briefly: The theory that alcohol is not oxidized but is eliminated entirely unchanged was proposed by Lallemand Perrin and Duroy in 1860 on the basis of experiments which were soon afterwards shown to warrant no such conclusion. Other experiments before and after 1860 showed that alcohol is oxidized. No prominent experimenter on the subject since 1870 has claimed anything else. The question was practically closed by 1875, and in 1883, accurate measurements by Bodländer showed that only very small quantities are given off unoxidized. The textbook states clearly that alcohol is eliminated without oxidation and makes this the basis of the claim that it can not serve the body as food. The indorsement in 1889 states that the textbooks of this series were written under the supervision of the scientific department of the Woman's Christian Temperance Union, published by its instigation, and had been "carefully revised from time to time to keep them abreast with the latest teachings of science." In 1900, this series, still bearing the same indorsement, was placed first in the list of the textbooks recommended in advertisements in a journal published by Mrs Hunt.

[Comparison of recent editions of Steele's *Hygienic Physiology* shows that, while a number of changes were made throughout the book in 1897, the revision of pages 177-79 was not made till 1900. *Note by Franklin W. Barrows, president of the association*]

Dr Didama—I have just a few words to say, and it will not take me any great length of time. There has been some discussion about the kind of books which are used in teaching temperance in the schools as the law requires. There have been some objections to the books which have been used, and some new ones, entitled the *New Century Physiologies*, have lately been

prepared by Dr Henry F. Hewes, the eminent teacher of physiologic and clinical chemistry in Harvard Medical College, and by Dr Hall, professor of physiology in Northwestern University. I have looked them over with some care within two or three days, and I think I can commend them as being quite free from the faults of the old books. Now whether alcohol is a food, as Prof. Atwater claims to have demonstrated—and I think many will go away from here satisfied that he did demonstrate it—or a poison with little food value, as is claimed by many of the most eminent physiologists, I earnestly protest against teaching children in our schools that alcoholic beverages taken in moderation are beneficial rather than injurious. Moderation is a word of dangerous use. Every criminal convicted of deeds committed when intoxicated, every one who died a drunkard was at one time a moderate drinker. Most of you know that more than $700,000,000 are expended in this country every year for alcoholic beverages, and that another $700,000,000 are required to punish the criminals and support the paupers who were made criminals and paupers by the use of these drinks. Years ago alcohol in the form of beer or whisky was thought to be necessary for laborers in hot weather, and specially in the cold of winter. In harvest time farmers used to lay in a large supply of whisky, because hired men would not work unless they could have their drinks regularly. It was generally believed in those days and is still believed by some people that a drink of whisky is good if exhausted or fatigued and excellent to improve the digestion. You all know the testimony of arctic explorers like Kane and Nansen, that men undergo cold better without alcohol, and Kane never administered any even when the thermometer went down to 80° below zero. Lord Kitchener, who was the commander in chief of the English army in Egypt, declared that his soldiers bore the fatigue of long marches and were better fighters and recovered sooner from exhaustion when they did not have alcoholic drinks, and they never had a drop of grog in all that long campaign. Kitchener knew that the dervishes were the best fighters in the world, and that, being

Mohammedans, they never used intoxicants, for this was forbidden by the Koran. Col. Ray, commandant of Fort Snelling, in Minnesota, informs me that beer-drinkers were the first to fall out in long marches and the most inaccurate marksmen that he had, when he needed good marksmen with these modern guns which carry to a long distance.

I want to ask this question: How many parents would like to have their children taught that alcohol taken in moderation is harmless, when, if it were known that these children used it, they would be excluded from employment in most kinds of business, from being a captain on a steamer, an engineer on a railroad, or any position of trust or responsibility? How many parents would dare to run the risk that their children might become inebriates and criminals from their personal use of this highly commended whisky food?

O. D. Clark—We have with us this afternoon a lady who has been most intimately connected with this movement of reform in the teaching of the effects of alcohol and narcotics; and I am sure we should all be delighted to hear what she has to say, and I think I represent the association in asking that the chairman do not enforce the five minute rule.

Mrs Mary H. Hunt—I agree most heartily with Prof. Atwater that we need not be afraid of truth. But the great question before us is, what is truth? I understand Prof. Atwater to say that the temperance teaching in the public schools is not in accord with the views of specialists and the latest scientific investigations and therefore is not true. In proof of this he cites his own experiments. The impression left on my mind and, I think, on the audience, is that he claims that Dr Rosemann, of Griefswald, sustains his (Prof. Atwater's) deductions from his Middletown experiments to the effect that these experiments proved that alcohol protects the albumen of the body of the drinker and therefore has food value as a beverage.

I, too, have been studying Dr Rosemann's 200 page article in Pflüger's *Archivs für Physiologie.* I regret that Prof. Atwater failed to give Dr Rosemann's conclusions drawn from his experi-

ments, for those conclusions put the whole matter in a very different light from that just presented to us. I happen to have with me a translation of the summing-up of the whole matter which Rosemann makes in his paper. He sweeps the beverage use of alcohol aside with these words: "It is generally agreed that alcohol can play no rôle as a nutriment in health. The only question, therefore, is concerning the employment of alcohol as a food with the sick"; and then there are grave doubts, and only experiments can give the final decision.

Dr Rosemann's experiments show that during the first four to six days when alcohol was taken there was a loss of albumen. This Rosemann takes into account in considering the advisability of using it as a food in sickness. He says: "If we were certain that an increased albumen loss would be easily endured by any patient for from four to six days, we might then obtain in alcohol, for the later period, an easily ingested albumen-sparing substance."

But he further says:

> I hold it quite possible that there are entirely healthy men whose cells do not become accustomed to the injurious effects of alcohol upon albumen, or at least only slowly and eventually not in full measure. If, therefore, under normal conditions the albumen-sparing action of alcohol does not always finally take place in the person in health, the result with the sick is to me still more doubtful. In any case, one can not without further evidence take it for granted that the cells of the sick will become accustomed to alcohol at the same rate as those of the well.

Hence, according to Rosemann, no one can foretell in any given case first, whether the body cells of the sick or well will ever become so accustomed to the injurious effects of alcohol that it will cause a sparing of albumen; and second, whether, in the case of the sick, the loss of albumen caused by alcohol during the time the body is trying to get used to it will not kill the patient.

It is a matter of public knowledge that Prof. Atwater announced to the world as one evidence of the food value of alcohol that he had proved that it protects the material of the

body from consumption as effectively as corresponding amounts of sugar, starch and fat; but it is likewise known that the published tables of his experiments do not support this conclusion, hence his conclusion has been discredited by the scientific world.

Dr Rosemann reviews the Atwater experiments in the article in question and says distinctly that they did *not* show a protection of protein, but on the contrary a very significant loss. Hence, we are unable to see how this statement of Rosemann accords with the claims made by Prof. Atwater for his experiments.

Furthermore, quantities of alcohol smaller than those given in the experiments to test its food value derange the nervous system to such an extent that the working ability of brain and muscle is diminished; hence from any rational standpoint alcohol can not be considered a food in the sense in which the word food is commonly used, i. e. as a substance whose nature it is to build tissue and furnish energy to the body without injuring any of its parts.

In referring to the report of the science committee, please allow me to disabuse your minds of one fallacy that seems to be afloat. The temperance education laws say, "the nature of alcoholic drinks and other narcotics and their effects upon the human system in connection with the several divisions of physiology and hygiene shall be taught all pupils in all schools," but there is not a line nor a word in the temperance education law of this or any of the other 44 states in this country or in the national law that specifies what shall be taught about alcohol or other narcotics. If this science committee can prove Dr Didama and all the doctors wrong and that alcohol is a food and not a poison, the school books will ultimately so teach, for truth can not be suppressed in this 20th century.

The argument of your committee's report that the oxidation of alcohol in the body proves it a food falls before the fact that other poisons as morphia, etc., are oxidized in the body, producing heat and energy, but that does not make them foods.

It is most fortunate that this committee proposes to continue its study for another year. Over against its quotations from Fothergill, who died 13 years ago, we suggest that they study the 2000 experiments recently performed in the laboratory of Prof. Kraepelin in Heidelberg, and others that show the absurdity of asserting that the nature or character of a substance changes with its quantity. Dr Koppe put this strongly before the International Medical Congress at Moscow, in 1897. He said:

The chemical nature of a substance can not change with the quantity, and can not be lost in the smallest quantity; but it must in every qualitative analysis remain the same so long as by progressive division this substance as such still exists, even down to the last molecule.

An essential, more than that, a vital truth has been left out of the committee's plea for moderate drinking, namely, the fact nobody can deny that a little alcohol has the power to create an uncontrollable and destructive appetite for more.

The English definition of a poison which Prof. Atwater gave does not fit the case. I know of no other definition of a poison as "a substance that can only do harm and never good to the body." Dr Didama will tell you that he sometimes gives his patients preparations of arsenic for medicinal purposes, that is, to do good to the body, but this does not make arsenic any the less a poison. Poisons are not substances that always do harm and never do good. The definitions of poisons in the school physiologies are in accordance with the definitions of great authorities like Taylor. In his standard book on poisons he says, "A poison is a substance whose nature it is when absorbed into the blood to injure health and destroy life." Education begins with first principles which lead on to larger developments of truth. If you are going to wait till children can understand all about any subject before you teach them anything, you may as well shut up your schools at once.

As to the complaint that there is too much temperance matter in the textbooks: if every detail of the question of the effects of alcohol on the human system were treated, one fifth

of the space of the books would not be enough to cover it, but that is not done. The amount of physiology and general hygiene that is needed in each successive grade of the school course is first computed, and then the proportion of temperance matter required for a clear statement of the facts that the pupils should know. From this we get the proportion of four fifths general physiology and hygiene and one fifth temperance matter.

I regret that there is not time to show you that the Connecticut temperance education law which has been recommended to you as a substitute for your admirable statute on this subject is only words, words, sounding brass and tinkling cymbal.

Prof. Bishop—I would like to ask one question for information. You said that certain poisons are oxidized in the body. On what experimental evidence is that statement made?

Mrs Hunt—I can give you the authority of such men as Dr Hall, a graduate of Leipzig, Dr August Forel and Dr Hewes.

Prof. Bishop—I have seen the statements, but I did not find that they were backed by any experimental proof or any evidence whatever.

Mrs Hunt—That can easily be furnished and I will be very happy to furnish it, but I shall have to refer to my library to do it.

Mrs Hunt—[Given later in answer to the above question] Experimental evidence that morphia, a poison, is oxidized in the body will be found in an article by Edwin S. Faust, in *Arch. für Experimental Path.*, 1900, v. 44. Wood's *Therapeutics*, edition of 1897, p. 677, cites the original works of authorities who have shown that carbolic acid is oxidized in the body.

Prof. Burt G. Wilder—I am satisfied that the last speaker and her coworkers, like Prof. Atwater and our committee, are all seeking the same good end, the welfare of the race. We differ, as has been said, as to the soundness of certain doctrines and as to the desirability of certain subordinate aims and methods. Unfortunately these differences are radical. But I trust the report of our committee, so far as it goes, may be accepted as a deliber-

ate and conscientious expression of our present views. The improbability of any material change in my own opinions may be inferred from the fact that they are now substantially what they have been for a third of a century. As a youth the subject gave me no concern. My parents were not total abstainers, but their four boys neither smoked nor drank, even beer, and I served through the civil war without once tasting whisky. But when, in 1868, I came to address the first freshman class at Cornell University on physiology and hygiene, I was compelled to decide what should be said to them, not merely as youths of that date but as future men and leaders in the community. And so, as if I had been their elder brother or their parent, I set myself prayerfully to ascertain what was the truth in this matter. I reached a certain conclusion, and that conclusion has not changed materially from that time to this. All that has been said, all that has been written, all the experiments that have been performed, all the arguments one way or the other, have not materially changed the opinion which I expressed then, which was practically embodied in the report of our committee today, and which I predict, though I may not live to see it, will be the prevailing opinion of the future, namely, that youths should avoid alcohol in every shape, for plenty of reasons; but that the average adult, who has not inherited a special tendency to be affected by alcohol, who is in ordinary health, under ordinary conditions, may use a certain limited amount, at meals only, and at the end of the day's work; furthermore, that all, even children, should be taught that this is the true doctrine. Personally, also, whatever freedom is permitted with respect to fermented beverages, wine or beer, I wish it were impossible to obtain at a saloon any distilled liquor to be drunk on the premises. One serious difficulty has yet to be overcome, viz, the inadequacy of the definitions of the terms that are employed in discussing this question. We have struggled with them and we are still at work. In particular, the phrase "moderate drinker," is evidently used in very different senses. With some it designates a person who is in peril

himself and likely to harm others. But at a meeting called by advocates of "No License," the president of Harvard University declared himself to be a "moderate drinker, that is, not a total abstainer, but using alcohol in moderation."

Mrs Ella A. Boole—The organization I have the honor to represent, the Woman's Christian Temperance Union of the State of New York, has a membership of more than 22,000, and a following of 30,000, so that I am safe in saying that I represent 25,000 mothers. These women are vitally interested in the training of their children, and, if I had a boy, I should have been sorry to have him hear what seemed like a plea here this afternoon for moderate drinking.

A student from Cornell, on being warned by his mother against drinking, replied, "Mother, it has been proved that it will not hurt a fellow to drink a little liquor. Prof. Atwater says so, and he is a college professor." I do not believe that Prof. Atwater wants to be quoted by college students as approving moderate drinking, but, because he is a college professor, because he insists that alcohol is not a poison, even though he says that boys under 21 should not touch it, they will construe it as safe for them to take an occasional glass, and such teaching is dangerous.

It is charged that some children have received incorrect impressions; but as an old-time teacher with some years of experience, I always used to think that this result was a reflection on the teacher.

If this has been the result of some of the teaching of physiology and hygiene with special reference to the effects of alcoholics and narcotics, it certainly is a reflection on the teachers, that they have not presented the subject in such a way that it could be comprehended by the pupils; and I believe the fault lies in the fact that methods of teaching have not been presented in the normal schools and teachers institutes in such a way as to impress the teachers that the object of this instruction is to make of the boys and girls intelligent total abstainers from liquor and tobacco.

Another point. I do not believe that the investigation undertaken by this committee has been entirely fair. They have meant it to be so. But, as the inquiries sent out went mainly to male teachers, some of whom may be biased in their views because they themselves use tobacco, to make the investigation perfectly fair, questions should have been sent to an equal number of men and women teachers, for there are many that believe in the law.

There is another class of people that ought to be consulted, and that is the mothers of the state. We women have something more than money invested in the boys and girls of the state, and we want them taught the truth in our public schools in such a way that it will make them intelligent total abstainers from liquor and tobacco. I could bring you the testimony of mothers who tell about the boys coming home from school, and telling of the bad effects of alcohol. I could tell you of the Wayside Home in Brooklyn, where years ago the girls used to come, and say they did not know that beer would make them drunk, and they took it innocently. There is scarcely a girl who comes there now who says that, because the children are taught in the schools that the alcohol in the beer, wine and whisky is a poison, and that, taken in small quantities, it has the power to create the appetite for more. This instruction is bearing fruit and that to the saving of our boys and girls from strong drink.

Another thought. I should be very sorry to have this meeting this afternoon reported in the newspapers. You may not look at it in the way I do; but the liquor interests are all too ready to spread such thoughts abroad, and they will construe this report as presented here this afternoon as an indorsement of moderate drinking, and even they believe in that.

We as mothers must insist that the youth of the United States must be taught that the danger is in the first glass of alcoholic liquor, and that it is never safe for man, woman or child to consider that there is no danger in taking liquor occasionally.

It was said this afternoon that no law was ever obtained by the united efforts of the temperance forces and the teachers except the Connecticut law. I happened to be a state officer at the time the present law was obtained here in New York state, and was present at a conference in New York city where were present Sup't Skinner and a number of prominent teachers of the state, and where we agreed on some of the provisions of the present law. We conceded some things at that time that there might be harmonious relations between the teachers of the state and the Woman's Christian Temperance Union, for both are and ought to be vitally interested in the welfare of our future citizens.

Prof. Brigham—It seems to me that we are in danger of losing sight as an association of the report which has been presented to us. It is well that we should bear that in mind. I am sure it must be right for us to consider, and through the medium of a competent committee to investigate the question of fact, the question of pedagogy and the question of morals involved. It must be right and useful for us to have such a report presented as has been presented, and it must be safe that such a report should have publicity. Have we duly considered the spirit of this report? Have we considered the amount of patient investigation, the anxiety and labor which have gone into it? The presumption seems to be from the reading of that report that something is wrong with the teaching about alcohol. We are not here to decide on the fact, helpful as the statements of Prof. Atwater and others have been to us. We are here to be sure that we are in the way of finding out the facts and the ultimate principles on which we should act; and I think that all present, though divided on certain matters, should agree that the report is admirable; that there is reasonable presumption from what has been said by so many teachers in New York State that something is wrong with the teaching; that, if we are not teaching error, we are doing what is almost as bad, we are teaching truth in an exaggerated way, and I am principally concerned for the assurance which I desire to have that this committee is to

continue its labors and be able to bring us some further light a year hence. I am sure you will all agree that the teaching of error never has been, and never can, under any circumstances, be good. There is no time now to discuss the effects on the teacher, or the effects on the pupil, of teaching even the truth in the way of overstatement; that is sure to work harm. I want to remind the association that, vitally interested as we all are in the problems of temperance, we are not here and now concerned with measures of temperance. We are concerned with finding out what is true on this particular question and how we shall present that truth to the children of the schools. And so I do not at all share the apprehensions of the last speaker, though I sympathize with her earnestness, as to the harm that is going to come from publicity, for "Truth is a good swimmer" and will gain the shore.

Mrs Graham—The circulars sent out from this committee on stimulants and narcotics naturally came into my hands. These circulars were read and discussed at the annual convention of the Woman's Christian Temperance Union of Onondaga county. Resolutions were passed at that convention and resolutions have been passed by both state and national conventions protesting very strongly against any movement to repeal the law of scientific temperance instruction in the schools. A committee to reply to these circulars was appointed by this convention, of which I have the honor to be the secretary. The replies were based on the consensus of the acknowledged authorities on the subjects touched on in the circulars. As soon as it was known in the state that there was a movement on foot to modify or repeal the scientific temperance instruction law, petitions began pouring in on me. I hold in my hand petitions which represent thousands and thousands of the women of this state. And petitions have come not only from the women but from the men, from every walk in life, from the mother in the home and from the teacher in the high school and college, from the leader of the primary department of the state Sunday school association, from a life insurance agency as well as from super-

intendents of homes for fallen women and unprotected girls, all protesting against any repeal or any modification of the present law, stating that they knew definitely, being the teachers of children, or men who have examined and investigated the habits of men for the purposes of insurance and see the necessity for greater enforcement, and a more intelligent and sympathetic treatment of the law and its teachings. All these come to me as protests from those who know the effects of the teaching on the present generation of children, and on all interests in the business and social world. I would like to read just one or two of these:

To the committee on stimulants and narcotics: "In behalf of the 1000 members of the Ulster county Woman's Christian Temperance Union, I earnestly urge the enforcement of the temperance education law," etc.

It seems to me that the one remedy which we need is not a change in the law, for the law wisely recognizes the great strides which science is making today, and says that "the *nature* of alcoholic drinks and other narcotics and their effects on the human system shall be taught in connection with the various divisions of physiology and hygiene, etc.,"[1] leaving to the findings of world-recognized scientific and medical men and bodies to declare what this *nature* is. Textbooks embodying these findings are written by experts along these lines. Not a change in the law, I repeat, but a greater knowledge on the part of the teacher. I too have been a teacher, and I know with what the teacher has to contend. I know the many duties that are hers, and I know too that, whenever a teacher has a wider and fuller knowledge of the subject which she has to teach, that subject takes on a new life and interest in her soul which must be and is felt by those under her instruction. Did you go on to the high school and college with a great love for mathematics? Did you make the greatest progress in that line of work? Then you must have had an enthusiastic teacher and an intelligent

[1] Ainsworth. School Physiology Law, with the amendments of 1896, section 1, § 19.

teacher, for that depends on truth alone. It is the truth that we are after, and, in all honor to the last speaker, I must say that what has been said this afternoon has a very close relation to the question at hand as represented by the committee, because the committee would have it taught that alcohol is not a poison. It is the truth we seek for ourselves and the children, and changing the state law of scientific temperance instruction will not help, but will positively hinder its being found. What we need is the hearty cooperation of teacher and temperance worker at the institutes and teachers meetings. If once in a while one of these meetings could be devoted to the instruction of teachers along temperance lines, by an expert, some one who by his life and experience or his professional studies or practice, has become an expert in that line—if such a one could be brought into contact with the teachers, do you not think there would be a better understanding of this subject and a more united and sympathetic working together for the child's highest good and that of the nation? For "Education is not a *preparation* for life, education *is* life."

Prof. Frank Carney—As a member of this association, I move the acceptance of this partial report of the committee on stimulants and narcotics, and also that the committee be continued.

Prof. R. E. Dodge—I second that motion. I feel that it must be extremely discouraging for a committee to work for four years to make a fair report and go away feeling that they have not received the support of the association. It seems to me that this report is the most scholarly, the most careful, the most conservative which has been presented before this association in the years that I have attended the meetings; and I think we ought to support Prof. Bishop and his colleagues in their statements that children should abstain, that they should be taught habits of self-denial, and that we must leave it to the adult to decide what he is going to do along this line.

[The report of the committee was accepted as a report of progress and the committee asked to continue its investigations.]

Mrs Martha M. Allen—I simply wished to say that the medical journals have contained many articles in opposition to Prof. Atwater's conclusions. While these articles admit that Prof. Atwater's experiments settle what was heretofore disputed, that alcohol is oxidized in the body, they declare that too much has been claimed as proved by the experiments; that it has not been proved that alcohol is a food. These writers show from Prof. Atwater's own published figures that he is in error in some of his main conclusions as presented here today.

Those physiologists who teach that alcohol is a poison experimented on animals, and afterward killed the animals, thus obtaining evidence of poisonous effects. Prof. Atwater is not a physiologist; he is a chemist. His experiments were on a man, hence he could not kill his animal to know the effects of alcohol on the tissues. His experiments were very limited.

MEMBERS 1901

When the name of an institution includes the name of its town or city, the latter is not repeated. Where no state abbreviation appears, New York is to be understood.

Allen, Charles M., Pratt Institute, Brooklyn
Allen, John G., Rochester High School
Anderson, W. W., Dobbs Ferry
Andrews, Kate R., 24 Kelly Hall, University of Chicago, Ill.
Arey, Albert L., Rochester High School
Armstrong, Charles H., 109 W. 54th st. New York
Arnold, J. L., 225 E. 23d st. New York
Atkinson, George F., Cornell University, Ithaca
Atwater, J. C., Canandaigua Academy

Babcock, Edward S., Alfred University
Barber, H. G., 241 W. 135th st. New York
Bardwell, D. L., Binghamton High School
Barrows, Franklin W., Buffalo Central High School
Beach, Channing E., Buffalo School 23
Beach, Grace B., 322 St Nicholas av. New York
Beadel, Charles W.
Bean, Charles M., Pulaski Academy and Union School
Belknap, Emmet, Lockport High School
Bennett, William M., 76 Wellington av. Rochester
Benoliel, Sol. D., 206 Washington park, Brooklyn
Bevier, Marie L., 106 W. 61st st. New York
Bickmore, Mary E., 30 W. 128th st. New York
Bigelow, Maurice A., Teachers College, New York
Binns, Charles F., N. Y. State School of Clay-working and Ceramics, Alfred
Bishop, Irving P., Buffalo Normal School
Blossom, Margaret, 183 Columbia st. Brooklyn
Bogert, Marston T., Columbia University, New York
Bond, William E., Potsdam Normal School
Boniface, Sister M., Nazareth Academy, Rochester
Booth, W. M., Cortland Normal School
Bowers, Emma, 100 Hector st. Ithaca
Brace, Edith H., 40 Courtlandt st. Rochester
Bradley, Theodore J., Albany Academy
Brigham, Albert P., Colgate University, Hamilton
Bristol, Charles L., New York University
Bronson, B. S., Geneseo Normal School
Brown, Miriam R., Erasmus Hall High School, Brooklyn
Brownell, W. A., 905 University av. Syracuse
Brownlee, R. B., Brockport
Burchell, Durward E., Oswego Normal School

Burgin, Bryan O., Albany High School
Burlingham, Gertrude S., 93 Oak st. Binghamton
Burr, Charles H., White Plains High School

Call, Richard E., Erasmus Hall High School, Brooklyn
Callahan, Eugene B., Richfield Springs High School
Carey, E. L., St John's College, Brooklyn
Carney, Frank, Ithaca High School
Carpenter, Idalette, Maplewood (N. J.) High School
Carss, Elizabeth, Teachers College, New York
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Cattell, J. McKeen, Garrison on Hudson
Chambers, V. J.
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Christian, Elizabeth, 8 Kemble st. Utica
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Clark, O. D., Brooklyn Boys High School
Clark, Tracy E., 102 Macon st. Brooklyn
Clarke, John M., New York State Museum, Albany
Clement, Arthur G., Regents office, Albany
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Evans, Susan, 205 Court st. Rome

Fairbanks, Floyd C., Geneva High School
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Fish, Pierre A., New York State Veterinary College, Ithaca
Fleming, Mary A., 432 Pearl st. Buffalo
Fox, Ada H., Masten Park High School, Buffalo
Freley, J. W., Wells College, Aurora
Fuller, R. W., DeWitt Clinton High School, New York

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Gage, Simon H., Cornell University, Ithaca
Gager, C. Stuart, New York State Normal College, Albany
Gaines, E. V., Adelphi College, Brooklyn
Gano, Seth T., Edmeston High School
Gardner, George S., 141 Clifton st. Rochester
Gemmel, Marion, Masten Park High School, Buffalo
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Gifford, T. I., Pike Seminary
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Glavin, John F., St John's Academy, Rensselaer
Goodrich, Arthur L., Utica Free Academy
Gorton, J. Irving, Ossining High School
Graham, W., Syracuse University
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Greene, W. J., Hoosick Falls High School
Greenwood, John W., Masten Park High School, Buffalo
Griffis, Henry L., New Paltz Normal School

Haanel, Eugene, Syracuse University
Hale, Albert C., 352A Hancock st. Brooklyn
Hall, James H., Cazenovia Seminary
Hallock, William, Columbia University, New York
Hancock, W. J., Erasmus Hall High School, Brooklyn
Hanna, Jennie P., 23 Prospect st. Rochester
Hargitt, Charles W., Syracuse University
Harris, C. Everett, Rochester High School
Hartnagel, Chris A., Hornellsville High School
Hering, D. W., New York University
Herrick, Lillian B., 408 Union place, Elmira
Hixon, Kate B., 24 E. 128th st. New York
Holdredge, L. I., Hudson High School
Hopkins, T. C., Syracuse University
Hoxie, Jane L., 109 W. 54th st. New York

Hudson, George H., Plattsburg Normal School
Humphrey, O. D., Jamaica (L. I.) Normal School
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Hurd, Frances, Oneonta Normal School

Jameson, J. M., Pratt Institute, Brooklyn
Jaquish, Benjamin M., 204 W. 106th st. New York
Jewett, Franklin N., Fredonia Normal School

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Lee, Frederic S., Columbia University, New York
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Lennon, W. H., Brockport Normal School
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Sweetland, Libbie, Dryden

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ATTENDANTS 1901

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Atwater, W. O., Wesleyan University, Middletown Ct.
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Barrows, Franklin W., Buffalo Central High School
Barrus, R. M., Keuka College
Beach, Channing E., Buffalo School 23
Bean, Charles M., Pulaski Academy and Union School
Binns, Charles F., N. Y. State School of Clay-working and Ceramics, Alfred
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Bliss, Carrie H., Leavenworth Institute and Wolcott High School, Wolcott
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Dodge, Charles W., 330 Oxford st. Rochester
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Hunt, Arthur E., Manual Training High School, Brooklyn
Hunt, Mrs Mary H., Woman's Christian Temperance Union, Boston
Jameson, J. M., Pratt Institute, Brooklyn
Jewett, Franklin N., Fredonia Normal School
Karr, Grant, Oswego Normal School
Kenyon, O. C., 110 Lancaster av. Syracuse
King, Alice Cynthia, Utica City Training School
Kirkwood, J. E., Syracuse University
Kittredge, R. J., Schenectady Union Classical Institute
Kneil, Thomas R., Saratoga Springs High School
Langworthy, William F., Colgate Academy, Hamilton
Lewis, Fred Z., Brooklyn Boys High School
Linville, Henry R., De Witt Clinton High School, New York
Lloyd, Francis E., Teachers College, New York
Long, Eli H., University of Buffalo
Longwell, Elizabeth J., Penn Yan
Lovell, Thomas B., Niagara Falls High School

Lyon, Howard, Oneonta Normal School
MacFarlane, C. T., Brockport Normal School
McMurry, Frank M., Teachers College, New York
Marcella, Sister M., Nazareth Academy, Rochester
Mershon, Bessie DeWitt, Utica
Meserve, Elizabeth E., Utica Free Academy
Miller, Gertrude, Penn Yan Academy
Miller, Mrs Mary Rogers, Cornell University, Ithaca
Monroe, W. S., Westfield (Mass.) Normal School
Morrill, Albro D., Hamilton College, Clinton
Mosher, C. L., Canton High School
Multer, W. J., Bay Shore High School
Newell, Lyman C., Lowell (Mass.) Normal School
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Pattee, Ernest N., Syracuse University
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Pingrey, Mrs Cora E., White Plains High School
Piper, P. F., Buffalo Central High School
Randall, Charles W., Lockport High School
Rogers, Charles G., Syracuse University
Round, R. J., Elmira School 3
Saunders, Samuel J., Hamilton College, Clinton
Schmitz, H. J., Geneseo Normal School
Schneider, Philip F., Syracuse High School
Shatz, Josephine, Rochester High School
Sheldon, C. S., Oswego Normal School
Sherwood, Leora E., Syracuse High School
Smith, Owen R., Amsterdam High School
Spencer, John W., Cornell University, Ithaca
Stoller, James H., Union University, Schenectady
Stowell, T. B., Potsdam Normal School
Tenney, Lloyd S., Brockport Normal School
Thwing, Charles B., Syracuse University
Turner, George M., Masten Park High School, Buffalo
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Warner, A. R., 36 Franklin st. Auburn
Wetmore, Edward W., New York State Normal College, Albany
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Wilder, Burt G., Cornell University, Ithaca
Young, I. E., New Rochelle High School

INDEX

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High School Department

INCLUDING ACADEMIES AND ALL INTERESTS OF SECONDARY EDUCATION

Bulletin 21

NEW YORK STATE SCIENCE TEACHERS ASSOCIATION

PROCEEDINGS OF THE

SEVENTH ANNUAL CONFERENCE

Held at Syracuse University, Syracuse, December 30-31, 1902

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1903

[illegible]   Price 20 cents

University of the State of New York

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With years of election

1892 William Croswell Doane D.D. LL.D. *Chancellor*, Albany
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One vacancy

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University of the State of New York

High School Department

INCLUDING ACADEMIES AND ALL INTERESTS OF SECONDARY EDUCATION

Bulletin 21

NEW YORK STATE SCIENCE TEACHERS ASSOCIATION

PROCEEDINGS OF THE

SEVENTH ANNUAL CONFERENCE

Held at Syracuse University, Syracuse, December 30-31, 1902

SUMMARY OF SESSIONS

Tuesday, December 30, 9.30 a. m.

Meeting of executive council

Registration

Opening session; called to order by Prof. WILLIAM HALLOCK, Columbia University

Culture Value of the Study of the Exact Experimental Sciences
Prof. WILLIAM HALLOCK, Columbia University

Ethical Value of Science Study
HORATIO M. POLLOCK, State Civil Service Commission

Discussion
Prin. THOMAS BAILEY LOVELL, Niagara Falls High School

Tuesday, 2 p. m.

General session

Education for the Professions
Director R. H. THURSTON, Sibley College, Cornell University

Tuesday, 4 p. m.

Section meetings

Section A—Physics and chemistry. Prof. E. R. WHITNEY, Binghamton High School, *chairman*

A Second Year Course in Physics for the High School
Prof. ERNEST R. VON NARDROFF, Erasmus Hall High School, Brooklyn

Section B—Biology. Prof. J. E. KIRKWOOD, Syracuse University, *chairman*

Value of Research in Botany

Prof. J. E. KIRKWOOD, Syracuse University

Discussion

Dr C. STUART GAGER, State Normal College, Albany

Prof. H. J. SCHMITZ, Geneseo Normal School

HORATIO M. POLLOCK, State Civil Service Commission

Prof. A. D. MORRILL, Hamilton College, Clinton

Professor HEUSTED

Section C—Earth Science. Prof. IRVING P. BISHOP, Buffalo Normal School, *chairman*

Exactly What should be given as Laboratory Work in Physical Geography?

Prof. AMOS W. FARNHAM, Oswego Normal School

Section D—Nature Study. W. H. BENEDICT, Elmira School 29, *chairman*

Informal Science in the Grades

Prof. WILLIAM HALLOCK, Columbia University

Wednesday, December 31, 9.30 a. m.

Section A—Physics and chemistry. Prof. E. R. WHITNEY, Binghamton High School, *chairman*

The Physics Machine Shop in Secondary Schools

Prof. L. V. CASE, Washington Irving High School, Tarrytown

Prof. WILLIAM M. BENNETT, Rochester High School

Prof. O. C. KENYON, Syracuse High School

Discussion

Professor CASE

Prof. GEORGE M. TURNER, Masten Park High School, Buffalo

Prof. W. J. GREENE, South Glens Falls High School

Section B—Biology. Prof. J. E. KIRKWOOD, Syracuse University, *chairman*

Experimental Physiology in the High School

Prof. M. SMITH THOMAS, LeRoy High School

Discussion

Miss KATHERINE S. WETMORE, Rochester High School

Prin. J. S. KINGSLEY, Newark Valley High School

Inspector CHARLES N. COBB, Regents Office, Albany
Prof. A. D. MORRILL, Hamilton College, Clinton
Miss GERTRUDE BURLINGHAM, Binghamton High School
Prof. J. E. KIRKWOOD, Syracuse University
Prof. FRED Z. LEWIS, Brooklyn Boys High School
HORATIO M. POLLOCK, State Civil Service Commission

Section C—Earth Science. IRVING P. BISHOP, Buffalo Normal School, *chairman*

Limitations of School Museums in Natural Study
Prof. R. ELSWORTH CALL, Brooklyn Institute of Arts and Sciences
Discussion
Prof. AMOS W. FARNHAM, Oswego Normal School
Inspector ARTHUR G. CLEMENT, Regents Office, Albany

Section D—Nature Study. W. H. BENEDICT, Elmira School 29, *chairman*

Relation of Nature Study to Physiology and Hygiene
ELIZABETH CARSS, Teachers College, New York

Wednesday, 11.15 a. m.

General session

The Laboratory Notebook and Certification for College Entrance
Vice Prin. E. R. WHITNEY, Binghamton High School
Discussion
Prof. O. C. KENYON, Syracuse High School

Wednesday, 2 p. m.

General session

Report of progress of the committee on stimulants and narcotics presented by
Prof. IRVING P. BISHOP, Buffalo Normal School, *chairman*

Laboratory Devices
Prof. O. C. KENYON, Syracuse High School

Adjourned

SUMMARY OF ACTION

Alcohol and narcotics. The committee on alcohol and narcotics made a report of progress and asked an extension of time to prepare a final report. *Granted.*

St Louis Exposition. Prof. H. J. Schmitz, of the Geneseo Normal School, was appointed by the council to represent the State Science Teachers Association on the committee to select exhibits for the St Louis Exposition.

Physics. A committee was appointed by the chairman of the physics and chemistry section to prepare a syllabus for 2d year physics. The committee is as follows: Prof. E. R. von Nardroff, Erasmus Hall High School, Brooklyn; Prof. R. J. Kittredge, Schenectady High School; Prof. Frank Rollins, New York; Prof. O. C. Kenyon, Syracuse High School; Inspector Charles N. Cobb, Regents Office.

Physiology. The following committee was appointed by the chairman of the biology section to prepare a laboratory course in physiology suitable for the high school: Inspector Charles N. Cobb, Regents Office; Miss Katherine S. Wetmore, Rochester High School; Prof. A. D. Morrill, Hamilton College; and Prof. M. S. Thomas, LeRoy High School.

Treasurer's report

For the year ending Dec. 31, 1902

Receipts

Balance on hand Dec. 28, 1901	$53 93	
Dues Dec. 28	18 ..	
Dues to Ap. 25, 1902	19 ..	
Dues to Dec. 1	8 ..	
Dues Dec. 28	28 ..	
Dues Dec. 30	62 ..	
"	2 ..	
		$190 93

Expenditures

Com. on alcohol and narcotics, I. P. Bishop	$37 86
Com. on alcohol and narcotics, B. Wilder	4 65
Janitor, Medical College	3 ..
Express and cartage	1 50
Miss M. L. Vanderzee, stenographer	15 ..
Mrs R. T. Kent, stenographer	18 80
Miss L. B. Millard, stenographer	3 65
Miss C. A. Norton, stenographer	8 79

Postage	$5 ..	
Freight on *Proceedings* from Regents	1 75	
Express on *Proceedings*	1 10	
Work and cartage	1 85	
Wrappers, paste	1 ..	
Mailing *Proceedings*	27 ..	
Mailing programs	13 ..	
Clerk hire on bills, copy, programs	21 ..	
Programs	21 50	
Stationery	2 75	
Cashing checks	60	
		$189 80
Balance on hand Dec. 31, 1902		$1 13

Committee reports

Nominations. The nominating committee made the following nominations:

President, Irving P. Bishop, Buffalo Normal School

Vice president, E. R. von Nardroff. Erasmus Hall High School, Brooklyn

Members of the council, A. G. Clement, Regents Office; George M. Turner, Masten Park High School, Buffalo

Elected.

Auditing committee. We have examined the accounts of the treasurer and find them correct.

E. R. Whitney, *Chairman*
I. P. Bishop
H. M. Pollock

1903 meeting. The council's report contained a recommendation that Syracuse be the next place of meeting, but appointed a committee of three to decide on the place of future meetings. This was carried.

ADDRESSES, PAPERS AND DISCUSSIONS

Tuesday morning, December 30

In calling the meeting to order, President Hallock expressed his regret at the unavoidable absence of retiring President Barrows, and his appreciation of the honor done him by the association in electing him to its highest office. He then presented the following paper.

CULTURE VALUE OF THE STUDY OF THE EXACT EXPERIMENTAL SCIENCES

BY PROF. WILLIAM HALLOCK, COLUMBIA UNIVERSITY

[Abstract]

In making the fight for the introduction of physics into the curriculum of the secondary school, and its recognition as a requirement for admission to college, too much stress has been placed on its informational value and its practical applications to the affairs of everyday life; and in the overemphasis of this side of the science it seems to have been forgotten that there is any other light in which to view science. The scholars are taught with care and detail the great battles of the world, the great military heroes are held up to be worshiped and their influence on nations and peoples and the trend of civilization is carefully explained. The invention of gunpowder, the printing by movable type and similar facts are fleetingly referred to, and a few so called scientific discoveries are included. While the names of the kings of England and other countries and their generals are learned by date and deed, even such names as Copernicus, Galileo, Bacon, Jansen, Newton, Gilbert, Volta, Galvani, Fresnel, Faraday, are either omitted entirely or placed in a lamentably inadequate light. For example, Newton is credited with his work on gravitation, which is but a very small fraction of his work, and Galileo's fancied martyrdom appears more as illustrating the intolerance of the church than an important scientific event.

The fault is with ourselves in not including in our general courses of physics and chemistry more of the historical and human side of the subject. Undoubtedly the press of time is the excuse for the omission of this culture side of the subject, but it is really much more important than much of the minute details which are served up as all important. Which is the more important, the destruction of the Armada or the invention of the microscope, two almost contemporary events? And which receives the more attention and is more impressed on the scholar's mind? Let us have more of the historical human side of science and we shall hear less about its slight "cultural value."

ETHICAL VALUE OF SCIENCE STUDY

BY HORATIO M. POLLOCK, STATE CIVIL SERVICE COMMISSION

Had this subject been proposed four hundred years ago to a devout man of that age, he would have said that science is mischievous; that the spirit of inquiry is opposed to the spirit of faith; that it is worse than useless to try to learn anything about the things of this world; that truth is to be sought in revelation, not by investigation. The men who dared to think independently in those days were few, and those who dared publish their thoughts were still fewer. When we read of Galileo's trial and condemnation, of the burning of Servetus, Ridley and Latimer at the stake, we can imagine what it meant to be an independent thinker in the 16th century.

While the men who look backward for authority and inspiration have stood still in the mists and fogs which are ever about them, the men who are looking for new revelations have gone forward. Their path has become smoother and their way brighter as they have advanced. For the offense of telling the truth, for which Galileo was imprisoned, Darwin was only cursed and ridiculed, while today Spencer is praised and admired. In the days of Henry 8 and of his immediate successors, the one who dared to raise his voice against the ideas held by the state was quite likely to lose his head. One hundred years ago such a one would be listened to impatiently, while today he would be made a professor of science or of higher criticism in a university.

The changed attitude toward science and scientific men is largely due to the work of scientists themselves. One after another great investigators have arisen and by their discoveries have proved the worth of their work. The crowd may jeer at the theorist when he gives them only theories, but they throng about him when he scatters gold and diamonds among them. The scientist has won his place mainly by his contributions to the physical well-being of mankind. His contributions to the moral well-being of the race are, however, none the less real, though not so easily recognized.

As first among these contributions to the moral elevation of man, I would name the scientific method—the method of research, inquiry, investigation and careful reasoning. The great principles on which this universe is founded are hidden from the vulgar gaze. He who would discover them must be a diligent student, patient observer, careful investigator and an unprejudiced reasoner. He must be willing to face danger, to risk health and to suffer pain. He must be willing to descend into the gaseous mine and into the depths of the ocean, to climb the lofty mountains and wander through the barren and frozen regions of the earth. Whatever is necessary in order to obtain facts, that he must do. Having obtained his facts, he must classify them and determine their significance. Then, and not till then, is he able to generalize and announce a principle to the world. Darwin accumulated facts and made experiments for over twenty years before he published his theory of development. Newton waited and sought many years in vain for facts to confirm a theory he believed to be true; finally the more accurate observations of another astronomer furnished the necessary data and the law of gravitation was the result. The science we prize so highly today is the result of such a method.

For a long time, observation, inquiry and investigation were confined to what we now call natural science, but a method which proved so productive could not be thus limited. We now have a science of government, a science of religion, a science of ethics and we speak of philosophy as a science of sciences. The scientific method is now applied to a large part of the domain of thought. As a consequence, we are becoming not only wiser but better. Superstition, bigotry and fanaticism are fast disappearing, and with them are going low motives of conduct, such as fear of evil spirits, fear of misfortune, and fear of future torment. A mind influenced by such motives is not free to receive higher ones; but, with the lower banished, higher motives may come in to rule the conduct and form the character. As men calmly study the various systems of religion and of morals, they find that, as a rule, an honest sincere purpose pervades them all, and, though many dogmas and generalizations in

the various systems are founded on error, men no longer condemn and persecute one another for the sake of religious opinions. Today we can hardly imagine a presbyterian persecuting a Quaker, but the early Puritans thought they were doing the will of God when they hanged four Quakers on Boston common. We have learned that no progress is made by persecution, that uniformity of belief is not essential to the moral and religious life, that freedom of thought and speech is much more to be prized than adherence to prescribed doctrines.

We have also learned to place a higher value on human life, to be more considerate to the unfortunate and to be less revengeful toward offenders. Contrast the present treatment of the unfortunate and criminal classes with that which obtained before the introduction of the scientific method. It is only within the past century that slavery was abolished in civilized countries. This great transformation in society was brought about, not by the leaders in religion or morals, but by the spread of a real knowledge of the evil, made possible by careful observation and investigation. Our forefathers used to contrive all sorts of torture for criminals and even resorted to the trial by ordeal to prove the guilt of suspected criminals. We laugh at Mark Twain's story of how the Eskimos threw the suspected thief in the ocean to determine his guilt; if he sank, he was to be declared innocent, but he swam to shore and thereby proved his guilt and was beheaded. Such procedure, however, is no more ridiculous and unreasonable than the torture inflicted on accused persons in England, France and Spain within the past three hundred years. In all of these countries the rack has been a favorite instrument for the punishment and torture of heretics and unwilling witnesses. In England, down to 1830, most severe punishments were inflicted for slight offenses. As late as 1818, a bill introduced in the English Parliament to abolish the death penalty for a theft of five shillings from a shop was defeated in the House of Lords. In 1820, the amount stolen to merit death was raised to 15 pounds. At the present time we are seeking to reform rather than to punish the criminal. We know that crime is largely due to *environment* and is as often the fault of society as

of the individual. The indeterminate sentence, the parole system, the cottage system, and the trade school for prisoners are all the result of the scientific method applied to criminology.

The sanitary conditions of life in cities, the humane treatment of animals, the recognition of the rights of labor, the general education of children and the advance of woman to a position of social equality with man, though the result of many causes, owe much to the scientific method.

The discoveries and achievements of science have also done much to raise the ethical standards of man. Before the great laws of nature were discovered, the belief that God was an arbitrary being was all but universal; but, when science proved conclusively that the properties of matter and the laws of energy never vary, that the heavenly bodies move constantly in their orbits, that the universe is a grand harmony which proceeds without interruption, then the belief concerning God underwent a corresponding change. A God of law, whose wisdom and power are manifest in all things, has displaced the narrow view of a haughty God sitting monarchlike, enthroned in the heavens above. The moral ideal has likewise expanded. The laws of justice and of good will know no more exceptions than the law of gravitation or the laws of motion. Huxley put it none too strongly when he wrote, "The safety of morality lies in a real and living belief in that fixed order of nature which sends social disorganization upon the track of immorality as surely as it sends physical disease after physical trespasses." When we believed in an arbitrary God, the moral imperative was found in the decrees of revelation; now we find it in the laws of our own being; then, duty was confined to the matters contained in the decrees; now, it is as broad as conduct itself. Kent emphasized the sublimity of this fact when he said, "Two things command my reverence: the starry universe about me and the law of duty within me."

The establishment of the development theory changed the whole trend of modern thought. Man no longer looks back to a golden age that is lost to him forever. His Eden now lies before him. The old doctrine of the fall of man was one of despair; the new

doctrine of the rise of man is one of hope and inspiration. With the experience of past ages to warn and to guide us, science tells us that we may go forward into a land of promise whose treasures of life and love far exceed anything the world has yet known.

We have been considering the ethical value of science study from a historical standpoint; we have now to inquire into the immediate moral effect produced on the student of science.

It is now only a little over 100 years since science was first studied in regular schools. I have no doubt that it would have been introduced earlier had it not been for the strong prejudices against science in ecclesiastical circles. It was held that science made men skeptical and irreligious, that it turned them away from all that is sacred and worthy of reverence. These prejudices have not disappeared, but they have lost their influence. Today science is as firmly grounded as any other part of the school curriculum. For some time it has held an honored place in the academy and the college; and we have yet to see the disastrous moral effects predicted by its enemies.

The fact is that science has a peculiar claim as an agent in the formation of character. The student of science is forming the habit of seeking for truth. As he studies physics, chemistry or biology, he is discovering facts for himself and is learning to apply tests to the statements he finds in the textbooks. He experiments, he observes closely and makes careful deductions, always with the ideal of truth before him. He knows that the writer of the textbook is not infallible, and that all scientists are glad to be corrected when they are in error. In no other branch of knowledge is the emphasis on truth so strong as in science. It matters not whether the student continues the study of science beyond the schoolroom. The habit of seeking and telling the exact truth will go with him and will prove a lasting influence in the molding of his character.

The true scientist has an open mind. He is ever alert to receive new ideas and ever ready to give up old ones that have proved worthless.

Such a man can not have strong prejudices. He decides only on evidence and tries to secure all the evidence he can before

making a decision. By so doing he becomes a man in the highest sense. He is sovereign of his own intellect and of his own will as well. The traditions of the past or the whims of the present do not sway him from his purpose. Popularity does not excite him; censure does not cause him despair. His ideal is before him, and he knows that in following it he can not go far astray. The study of science also shows the importance of little things and inculcates the habit of carefulness and accuracy. In every branch of natural science the most refined methods are adopted and the greatest care is exercised in order that the determinations may have a permanent value. Speaking on this point, an astronomer recently told me that the majority of the principal stars are determined within $\frac{1}{10}$ second of arc, which is an average of about one twelve-hundredth of the apparent diameter of a bright star. He also reminded me that some of the greatest triumphs of astronomy were due to high standards of accuracy. A discrepancy of about 2 minutes of arc, a distance less than can be distinguished by the naked eye, between observations and computations gave to the world the eighth planet. The orbit of Sirius and its less brilliant companion was discovered by absolute determinations of Sirius extending over a period of about 120 years. We can imagine the care and patience required for such a task when we realize that the radius of the orbit is only 2 seconds of arc, or about one hundredth of the apparent diameter of Sirius and that the orbital period is about 50 years. In physics, chemistry and biology, the same painstaking accuracy has produced results just as marvelous.

Nature reveals her secrets to the student of science as to no one else. Among these secrets there is many a tale of success through industry and cooperation and many a tale of failure through sloth and selfishness. "Go to the ant, thou sluggard, consider her ways and be wise" was told to an observer hundreds of years ago, but the world has not yet learned that labor is better than ease and that mutual helpfulness is better than strife. The story of parasitism tells how many a respectable plant and animal has fallen on account of laziness and greed, and the story of the fragrant flowers shows how the flowers which offer most

for the enjoyment of others receive most aid in carrying out their own designs.

Moreover, a diligent study of nature awakens in the student a love and sympathy for all living things and fills his mind with pleasing and ennobling thoughts. How well is this fact exemplified in the lives of great nature lovers like Agassiz, Thoreau and Burroughs. To such men the voice of nature is truly the voice of God.

The most pressing need of our schools today is more effective moral instruction. With all our improved methods of teaching, we fail to exert the desired influence on the character of our pupils. The defect it seems to me lies in the fact that we are only partially applying scientific principles to the problem of character building. Science tells us that the two important elements in the formation of character are heredity and environment. With the first of these elements our schools have little to do, but the school forms a large part of the child's environment. If we are to expect the best results, this environment should be such as will produce a moral reaction on the part of the child. Our school buildings should be roomy and well ventilated, and they should be surrounded with parks and gardens. The walls of the schoolrooms should be tastefully decorated and hung with real works of art. The books which teach low ideals and low standards of conduct should be banished from the school. The stories of the barbarity, cruelty and savagery of the human race have no place in the schoolroom. In their stead, we should put the books which tell of the triumphs and achievements of the men of industry, science, art and religion. Above all, if our school is to have a moral influence, the teachers must be men and women of the highest character, men and women who are not afraid to emphasize truth, justice and good will in all their teaching and in the management of the school.

As teachers and lovers of science we are called to have a large part in the moral training of the youth of our land. In teaching earnestly the things of science, we do well, but, if at the same time we inculcate the scientific spirit and a love of nature and truth, we do better.

Prin. Thomas Bailey Lovell—Many years ago, when I was principal of a school in western New York, the janitor one morning entered my office to take care of the fire. After he had shaken the grate, he sat back on his heels, and, looking up to my face as I sat at my table, said, "Principal, I think I am the most important person in this institution." With some surprise I said to him, "How so?" "Well," he replied, "if I did not take good care of these fires and prepare the rooms for you and the teachers, you could not do your work." I admitted the truth of his statement and honored him because he honored his work.

In a spirit quite similar to that of my former janitor, I beg leave to say, we of the high schools are among the very important forces at work in the construction of this educational cathedral. Without us you can do nothing, for we are at the bottom, working on the foundation; and, if that is not securely made, the superstructure is endangered, however beautiful it may be, and however artistic and proportionate its walls, its arches, its spires, and vaulted roof. In going from the high school to the college and the university, we progress from foundation stones to the groined arches and surmounting dome.

We should approach the subject of science teaching with a consciousness of its importance and a due sense of its relation to other departments of work required of the student. He who was for a third of a century the honored president of the University of Rochester, when he was at the hight of his power of mind and body, gave this as a definition of science: "Science is the discovery and registration of the laws of God as revealed in the universe of mind and matter." This is a broad statement. It excludes nothing from classification, a psychologic phenomenon being as much under the domain of law as a physical fact. With the psychologic aspect of this definition we will not concern ourselves.

The discovery, in the world of matter, of law or the governing principle is but another expression for the discovery of truth, and truth is knowledge, and knowledge is the inspiration of mind and the condition of its enlargement. The discovery of truth in the realm of mind or matter is thus placed on the same

basis. A ground of correlation is here established. Whatever value we may ascribe to the study of psychology and the discovery of its laws, nearly the same value must be given to the study of the physical and biologic sciences. I say nearly the same value, because I recognize a difference between the thinker and the thing thought, between matter and mind.

If the student has acquired good habits of observation, proper methods of classification, approved ways of comparison, and by this obtained accurate means of arriving at results, it must be acknowledged that he is the better prepared to investigate and discuss the laws of history and to consider the conditions of life and environment necessary to produce the different phases of literature. Even to follow the severely logical processes of geometry calls for no different application of mind power from the equally severe logical processes of the laboratory, whether exercised on living forms to discover or trace the laws of life and growth, or on dead forms or atoms to trace the law of development or the condition of crystallization. As an aid to the student in history and literature the scientific habit is invaluable.

No indefinite or easy going work should be permitted in the laboratory, nor loose statements or illogical grouping of ideas permitted in the notebooks. The teacher of Latin or Greek will not be satisfied with a translation that is not true to the author studied; the teacher of chemistry will not be satisfied with an experiment, its record and interpretation, unless it be true to nature, the author. The study of science tends to the study of truth.

The heart of Columbus was filled with no greater joy at the result of his first memorable voyage than was the heart of Berzelius at the possible results of his work in his crude laboratory in 1800 and in 1805. It was the truth he spoke, and it was this truth, dear to mankind, that brought honor to his name and a lasting remembrance by the people.

A mere fact is not science, neither is the best method science; but the discovery of the relations of this fact and why they are so, and the results of the method applied lead to that accuracy of judgment and statement which will give authority to the expressed conclusion.

The value of accuracy shows itself in every department of life. It marks the difference between him whose word is as good as his bond and him whose statements must be taken with much allowance. It makes the distinction between the mechanic whose work passes inspection and the mechanic in whose work the imperfect joints and the lack of polish and perfection display the easy going, anything will do method. Such results react on the worker. It is not bad luck, but bad working habits that keep him down in the scale of life.

Certain departments of mechanical and electrical engineering depend so much on complete accuracy of fittings, adjustments of time and motion that without these the car would not move, the wheels would not turn, and we should again live the slow, difficult life of our ancestors.

Accuracy of statement is needed, if possible, much more by those who appear before the public to give the results of their studies and investigations in the form of addresses, sermons, lectures, judgments. The statesman whose deliverances are to affect the opinions and even the votes of the people, has no assurance that the people will rise and call him blessed, if his statements are tinged with inaccuracy, resulting from careless habits of thought and procedure. The preacher may obtain temporary popularity from exaggerated forms of expression and from conclusions based on too limited reading and study, but he will eventually lose his grip on the people and finally pass into obscurity. Training in scientific habits of investigation extends its influence into all the fields of study and thought. Truth is everywhere in the world, waiting for the Aladdin whose lamp is the symbol of energy and whose ring is the emblem of accuracy.

> "Beauty is truth, truth beauty,"—that is all
> Ye know on earth, and all ye need to know,

wrote the poet Keats with scientific accuracy.

Browning recognized that truth is everywhere, in all his poems referring to truth and investigation. The concluding lines of his poem, "The Two Camels," are remarkably expressive.

> Wherefore did I contrive for thee that ear
> Hungry for music, and direct thine eye
> To where I hold a seven-stringed instrument,
> Unless I meant thee to beseech me play.

The Creator is represented as speaking. The ear with its reverberating arches, and with its keys and vibrating strings, is hungry for music and harmony. Light with its seven colors affecting the optic nerve, invites the accurate investigation of the scientist into the truth of its revelation.

The world is made for us to study and to discover; for therein does the Creator take delight.

Browning also hints at the limitations of man's powers of investigation. Hear him in the same series of poems, *Ferishtah's Fancies:* "A Bean-stripe."

> To know of, think about —
> Is all man's sum of faculty effects
> When exercised on earth's least atom, Son!
> What was, what is, what may such atom be?
> No answer! Still, what seems it to man's sense?
> An atom with some certain properties
> Known about, thought of as occasion needs,
> — Man's — but occasions of the universe?
> Unthinkable, unknowable to man.
> Yet, since to think and know fire through and through
> Exceeds man, is the warmth of fire unknown,
> Its uses — are they so unthinkable?
> Pass from such obvious power to powers unseen,
> Undreamed of save in their sure consequence:
> Take that, we spoke of late, which draws to ground
> The staff my hand lets fall: it draws, at least —
> Thus much man thinks and knows, if nothing more.

If the study of science is of so much importance to the student in his other studies, and if the value of the habit of accuracy is so great, we must realize how essential these are to success in business matters, professional affairs and statesmanship. Competition in business is sharp, but he whose statements are true, and whose work accords with this accuracy of statement, will in the long run be honored by his fellow citizens, and reap the satisfaction of an excellent life, and in most cases win a competence.

If the value of scientific study is found in the possession of the scientific habit, that is the habit of accuracy, of careful investigation, of deducing just conclusions, of discovering the laws of God in nature, it has also a supplementary and higher value

in impressing on us the exactness of truth and the immutability of law. If there is an infinite law in the disposition of the atoms forming the petals of the rose, there is also an infinite law that controls the disposition of the atoms in the optic nerve. If there is a change in the disposition of the atoms of the diamond, and in its law of crystallization, it ceases to be the brilliant gem and becomes the dull charcoal fit for the fire and for lower uses only.

If law is inexorable in nature, it is also inexorable in the science of human duty. If the influences, infinite in number and infinitely small it may be, that make up the principles of right, duty, oughtness, are changed or diverted from their original purpose, the brilliancy of righteousness ceases, and the darkness of a broken law appears with the painful realization of maladjustment with the demands of the great Lawmaker.

Science teaches truth, and the truth is God.

Tuesday afternoon

GENERAL SESSION

EDUCATION FOR THE PROFESSIONS

BY DIRECTOR R. H. THURSTON, SIBLEY COLLEGE, CORNELL UNIVERSITY

The preparation of the man who has chosen to enter a profession involves properly suitability for the profession chosen, in character, ability and a special talent, if not a genius, as a basis and an excuse for that preparation. It should include a general education sufficient to give the individual the knowledge and culture demanded, in this generation, of all who aspire to enrol themselves in the ranks of the leaders of the professions, broad enough and deep enough to command respect and to justify confidence both in the man's attainments and in their utilization. It must involve training, both gymnastic and "practical," and development of that strength and maturity without which the professional apprenticeship of the special school can not be appreciated or its best results attained. Education, in the commonly accepted meaning of the term, should be carried as far and as high as the time, the means and the ability of the man permit and continued, if possible, till he has acquired maturity, earnestness, *intelligent* ambition and thorough assurance that he has

chosen the right field of work for his life's long endeavors. Yet, from the day when it becomes certain that his field of work may be safely selected, a thread of special preparation may run through all the sequence of his studies without injury to their value in the development of the man.

Mathematics may be taught by examples selected from the practical problems of the coming days of professional work; modern languages may be given large place in the curriculum; the sciences may be studied in a serious manner and intensively; these latter studies may be made to conspire for his advantage in the reading of scientific matter in foreign literatures. In many and very various ways, the bent of the child, the youth, the man, may be favored without loss of culture and with the great advantage of stimulating and maintaining his interest throughout. But, in the earlier stage, it would be a mistake to sacrifice culture and gymnastic training, true education, to professional training. Quite enough can usually be accomplished in the manner just indicated without observable distortion of the general education which every youth should rightfully claim. As secondary education and collegiate work in the "liberal" arts are today conducted, it is probably always possible to secure a large part of the needed scientific and linguistic preparation for professional study before entrance into the professional school, and, as in law, for example, it is seldom wise to attempt to incorporate such work in the curriculum of the school.

It is becoming more and more common to exact of the candidate for admission into professional study the preparatory work which brings with it the diploma of a reputable college giving a liberal B.A. course. In the professional school, it is sometimes sought to arrange a system of electives for the B.A. course in the university or the college, such as will best combine its work with the requirements of the professional school, and will thus permit the accomplishment of the two lines of work in a reduced period, as, for example, at Cornell, in the Colleges of Arts and Sciences and of Engineering, in six years.

It is progress such as this which justifies the comment of Wendell Phillips *regarding the* value of modern education and

that of Andrew Carnegie respecting the changes which have justified the words of that great orator, in our day as never before:

"Education," says the orator, "is the only interest worthy the deep, controlling anxiety of thoughtful men." Says the business man and philanthropist: "The changes and the advances made in education, in deference to modern ideas, have almost transformed our universities. These now give degrees for scientific instruction upon the same footing as for classics. . . No university could stand today which had not changed its methods and reälized, at last, that its duty was to make our young men fit to be American citizens and not to waste their time trying to make poor imitations of Greeks and Romans."

Now, as never before, education is coming to represent the ideal of John Milton, so often quoted and so rarely disputed, an ideal that can not be too often or too impressively placed before the youth of our own day: "I call a complete and generous education that which fits a man to perform, justly, skilfully, and magnanimously, all the offices, both public and private, of peace and war." This ideal was embodied in the plan of Cowley for a "Philosophic College" more perfectly than in the curriculum of any modern institution till, in fact, that aspiration began to find expression in the liberalized and enriched elective system inaugurated by President Wayland, and till, in the last generation, Ezra Cornell proclaimed his aspiration to "found an institution in which any man can find instruction in any study." This modern, and now almost universally accepted, Miltonian curriculum is based on principles well stated by Forel:

Education should promote comprehension and combination, but discharge the vast work of memorizing as much as possible upon books, which should be merely consulted, not learned. Make haste to forget useless trash. It obstructs your own thoughts, paralyzes your artistic sense, and dries up your emotions. Read only the choice books from among the thousands with which we are flooded.

Man must seek to improve his brain "by a sane, voluntary and rational selection, rather negative than positive, by instructing both sexes, and by urging the most highly organized brains and *bodies to* reproduce themselves as much as possible, while forcing

the inferior and incompetent ones to the opposite direction." This reform secures evolutional perfectibility, while the educational reform meets the conditions of superadded perfectibility; and only thus can the greatest of human problems be solved.[1]

The same idea is expressed in somewhat different words, and, as viewed by Huxley's different type of mind, from a different standpoint, thus:

That man, I think, has had a liberal education who has been so trained in youth that his body is the ready servant of his will and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic-engine, with all its parts of equal strength and in smooth working order, ready, like the steam engine, to be turned to any kind of work and spin the gossamers, as well as forge the anchors, of the mind; whose mind is stored with knowledge of the great and fundamental truths of nature and of the laws of her operations; who, no stunted ascetic, is full of life and fire but whose passions are trained to come to heel by a vigorous will; the servant of a tender conscience who has learned to love all beauty, whether of nature or of art, to hate all vileness, and to respect others as himself.[2]

The right sort of liberal education obviously begins in childhood with the growth of the observational faculties, continues through youth with the development of the power of comprehension and reflection, is finally terminated, so far as formal education goes, with those studies which are the expression of the thoughts or of the discoveries or of the deductions of great minds and which demand the employment of mature, acute, powerful and trained talent.

This is the university period, and, if this can be prefaced to the professional training, the man is indeed fortunate. It is the modern incorporation of the Miltonian ideal into our educational work that makes it possible for one of our ablest business men to say:

It used to be assumed that education was a hindrance to "success in life." The great merchant was to begin by sweeping out the store. The weakling was the proper candidate for college, whence a living might be assured him in the church or other

[1] Forel, August. University of Zurich. Current Encyclopedia, November 1901.

[2] Huxley, *2: 320.*

"learned profession." A college education was thought a handicap against "practical" achievement. This superstition is one of the husks the world has thrown off.[1]

In an ideal university, as I conceive it, says Huxley, almost in the words of Cornell, a man should be able to obtain instruction in all forms of knowledge and discipline in the use of all the methods by which knowledge is obtained. In such a university, the force of living example should fire the student with a noble ambition to emulate the learning of learned men and to follow in the footsteps of the explorers of new fields of knowledge. And the very air he breathes should be charged with that enthusiasm for truth, that fanaticism of veracity, which is a greater possession than much learning, a nobler gift than the power of increasing knowledge; by so much greater and nobler than these as the moral nature of man is greater than the intellectual; for veracity is the heart of morality.[2]

This declaration should be accepted as the fundamental principle, and the very inner spirit, of true education in all departments and as being as truly characteristic of the right form of culture as of the correct method of seeking professional knowledge. It is a characteristic of every correct form of study or of aspiration.

The "ladder" which, in our country, leads "from the gutter to the university" for every man who, possessing brain and physical vigor, wills it, includes the successive rounds of the public school system. The purpose of that organization is to fit, as well as may be, "all sorts and conditions" of youth for the life of the average citizen of our republic. It properly includes in its curriculum only those subjects which are of most value to the average citizen and it can not, and should not be expected to, provide either those luxuries of education rightfully desired by the well to do, or the special forms of training demanded by those proposing to enter on special lines of work, as into any of the professions. If it offers manual training, it is because that is found, on the whole, advantageous to all citizens, and sufficiently so to justify its insertion into an already crowded curriculum. Should, here and there, as in Europe, often, a trades school be established, it should be justified by the general demand among

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[1] *Bowker, R. R.* Of Business. 1901.

[2] *Huxley.* Coll. Essays, 3:189.

the people of the vicinity for such a training, being a requirement of the place as a seat of the special manufacture, or, as with the common trades, by its systematic teaching of principles and methods that meet the needs of all and which can not be as readily, perfectly, completely and economically taught by other systems.

That "ladder" includes our secondary schools, in which a selected body of youth are collected who have been found, by a sort of evolutionary selection, to be exceptionally well fitted to receive that higher sort of instruction. Here it is often possible for a determination of the choice of vocation intelligently and safely to be made. The polestar may be discovered and the course may be laid directly for the desired haven. But this course must be steered, as best possible, through available and safe channels, and the youth seeking ultimately to enter a great profession may be compelled — often indeed, greatly to his advantage — to follow the courses set for him by the school which is intended to promote the education of other sorts of minds. It is commonly the fact, however, that the studies here offered include those fundamentals of professional preliminary work which should always be acquired previous to entrance on purely professional study, and hence time is not wasted in securing this, which is also, fortunately, always desirable culture.

The preparation of the aspirant for entrance into a profession involves the provision of a fundamental knowledge of means of acquirement of professional knowledge, and this means acquaintance with the languages in which the literatures of the profession are to be found. In the case of the law school, this means Latin; with the theologist, it includes Greek and Hebrew; with the medical man, it means mainly Latin, as with the others, so far as affecting early history; while, with all, this means the necessary acquirement of the modern languages, French or German, or more commonly both, and sometimes Italian and others. In engineering, it involves the acquisition of the modern languages, the sciences of the physicist and the chemist, of the mathematician, sometimes of the geologist, and of the mineralogist; and it supplements these with special studies furnishing the *peculiar, "expert" knowledge* constituting preparation for the *characteristic branches of the* professional course.

When the whole course of preparatory work is surveyed, from primary to secondary and special, and when its relation to the strictly professional course is noted, it will be found that the latter involves so much of the admittedly educational, as distinguished from the professional, work that it thus becomes practicable for the aspirant to give all the years which his individual means and his time may allow, and most profitably, to liberally educating his faculties and to the storing of his mind with useful knowledge.

Says Dr W. T. Harris, the philosophic educator and psychologist:

Specialization in science leads to the division of aggregates of knowledge into narrow fields for closer observation. This is all right. But, in the course of study in the common school, it is proper and necessary that the human interest should always be kept somewhat in advance of the physical.[1]

This is simply a statement of the fact, admitted by all, that professional training in the special school is the application, in a restricted field, of principles which should be applied in every field and in all studies, whether those characteristic of a profession or those which constitute divisions of a broad, liberal and cultural education. But it is also true that, before specialization can be properly commenced, the scholar must have terminated that division of his education which is intended to give him general preparation for "the future of his life." It is true that a certain amount of specialization may be practicable in the preparatory years; but it is none the less true that, in preparation for the latest stage, the student must give main attention to the educational side and leave the professional to be given main attention in years following those of growth and of development of character and of intellectual power.

The guiding hands of parent and teacher may do much in the adjustment and regulation of the educational life and progress of the young in securing that correct perspective and that direct course from haven to haven which, only, can give the highest possible result in training, in education, and, finally, in professional

[1] *The Forum*, January 1901.

life. The best disposition of time, the best choice of subjects of study, the best adjustment of hours and the most satisfactory appropriation of time to work, to play, to gymnastics, and to practically fruitful exercises of mind and body, can only be determined by wise and experienced advisers.

Referring to industrial and professional training, Dr Lyman Abbott says:

> Industrial education, in the broad sense of the term, is a function of the state; not because it is the duty of the state to give to every, or to any, man a training in his profession, but because it is the function of the state to prepare a man for self-support. One difficulty with our system of education thus far seems to me to be that we have paid too much attention to the higher education and too little to the broader education. We need to broaden it at the base even if we have to trim a little at the top.[1]

The importance of the provision of every citizen, of either sex, with systematic and scientific preparation for the duties of life is thus a most essential provision for the future of the state. Even were we not compelled, in providing for the individual, to make provision for systematic education and training in subjects that relate to the useful arts and the duties of everyday life, it would be none the less imperative, as being vital in the maintenance of the highest interests of the people as a whole. We can not escape this duty either individually or as a nation, and it is supremely important that we go about our work in a systematic and intelligent manner.

Regarding methods, it is interesting to observe how completely educational processes have changed, in the last generation, in every department and in every division. The old methods, which reminded one of the stuffing of the Strasbourg goose, have largely disappeared; and, while it must be admitted that work under high pressure is now too generally the rule, it may be claimed that a very great gain has been effected in finding reasonable ways of teaching, and specially of importing into the study of serious, and perhaps intrinsically difficult and uninteresting, subjects methods of treatment which render the task far more attractive than formerly.

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[1] Abbott, Lyman. *The Rights of Man*, p. 161.

The system of instruction by didactic methods still exists in places, but only because the machinery for carrying on the work on more rational principles has not been obtained. Wherever the object is education, the methods of research have been introduced, and it is recognized that real scientific knowledge can only be gained by individual experience.[1]

This is as true of other subjects than those which, like physics and chemistry, like all the naturalist's subjects, the observational and experimental, seem necessarily to carry with them the paraphernalia of the laboratory. In every department of study there is some method apposite to that line of work which permits an appeal to the sense of inquisitiveness — a fundamental element of human nature and a most admirable and desirable one — and gives thus a means of approaching the mind by a direct and pleasant path. This is a principle now coming to be accepted as axiomatic, in education, in all its branches, and the once "dry-as-dust" subjects are taking on new life and assuming lovely and engaging forms.

Thus we may steadily keep in mind, through the whole career of the youth intended to take part ultimately in the constructive work of the world, the fact that he must after a time take up technical studies, and that, the more the work of the later years can be facilitated in the earlier, the better and the more profitable the earlier as well as the later work. The courses of instruction may perfectly well be made to include work in literature and in the pure sciences which is both valuable in the early gymnastic branches of education and useful in the later professional work. The earlier courses, in the case of the pupil, for example, who is proposing to fit himself for entrance into engineering or architecture, may perfectly well, and wisely should, be made to include just as much pure mathematics as can be had, just as much of chemistry and physics as the schools can provide and the modern languages in liberal amount.

Assuming that the aspirant for admission to the professional school, in this department, may follow his own bent, and that he desires to be educated and cultured as well as professionally expert, he will continue his work into the higher education, and

[1] *Sir John Gorst* at the Glasgow meeting of British Association, 1901.

there will elect advanced mathematics, will secure opportunities for experimental work in the physical laboratory, for work in analysis and synthesis in the chemical laboratory and for the study of the technical as well as of the literary, works of modern writers in French and German and possibly in Italian and Spanish. If he is preparing himself to take up ultimately law or medicine or theology, he will similarly find in the college and university curriculums various branches of study which will be of service either in shortening or in supplementing his work in the professional school. All such opportunities being taken advantage of, it will be found that the total time required to secure first an education and then a professional training will be greatly abridged without sensible loss in final results.

There are often subjects obtainable in the educational curriculum, or at least obtainable in connection therewith, which will be found either to constitute a part of the required work of the technical course, or to be likely to prove of special interest and advantage in connection with it, and which may be incorporated with advantage to the former course, also. There are many subjects, outside the liberal courses as usually prescribed, which, nevertheless, will be found quite as valuable, as cultural and as educational, as are some subjects which are the usual elements of that older scheme. The wise man will look for opportunities to secure a good hold on these, in substitution, if needs be, for more usual electives.

It will also be sometimes found that, to the earnest, competent and ambitious man, the commonly prescribed courses of instruction are by no means sufficient to provide a good day's work, each day, and that he may, with great advantage and without the slightest difficulty or sacrifice, increase the prescribed time and number of subjects by perhaps a third. He can not afford, in fact, to forego the opportunities which present themselves in such numbers and such wealth, up to the natural limit of his powers of safe and healthful exertion. He has but one such opportunity in his lifetime, and only the man lacking in intelligence or in moral fiber will waste one hour of such precious time. In the large universities and the leading colleges of our time, the student is perplexed and embarrassed by the wealth of opportunity

which is presented him. He will usually find that it will require very great care and deliberate thought to make a wise choice of subjects, to adjust himself to a wise limitation of time, so to adjust and schedule his work and his play as to make each day and each college year in maximum degree profitable. This he should do, having in view the common life, private as well as professional, and contemplating the utilization of that life most perfectly in the promotion of the highest interests of self, family, friends, country.

Thus, in summary, the ideal preparation of the aspirant, professionally, involves even a supervision of the child in its earliest efforts to obtain a knowledge of the outside world into which it has been introduced, a guidance of kindergartner and of the pupil in the elementary schools in the acquirement of those fundamental knowledges which furnish the means of acquirement of all knowledge, a discreet steering of the course of the older student in the preparatory schools and the finishing school or the college, and deliberate, earnest and careful choice of subjects of study and investigation in higher learning; all to the purpose of insuring that no hour of work shall be wasted by misappropriation to studies which have a less value for the ultimate purpose of the individual life than others equally available.

The preparation of the aspirant to professional standing and distinction, or even to the most modest success, thus involves wise counsel from older and more experienced minds, from the earliest to the latest years of this long apprenticeship.

Francis of Verulam thought thus, and such is the method which he determined within himself, and which he thought it concerned the living and posterity to know.

Being convinced, by a careful observation, that the human understanding perplexes itself, or makes not a sober and advantageous use of the real helps within its reach, whence manifold ignorance and inconveniences arise, he was determined to employ his utmost endeavors towards restoring or cultivating a just and legitimate familiarity betwixt the mind and things.

Bacon says, also:

And whilst men agree to admire and magnify the false powers of the mind, and neglect or destroy those that might be rendered *true, there is* no other course left but, with better assistance, to

begin the work anew, and raise or rebuild the sciences, arts, and all human knowledge from a firm and solid basis.

Nor is he ignorant that he stands alone in an experiment almost too bold and astonishing to obtain credit; yet he thought it not right to desert either the cause or himself, but to boldly enter on the way and explore the only path which is pervious to the human mind. For it is wiser to engage in an undertaking that admits of some termination than to involve oneself in perpetual exertion and anxiety about what is interminable.

In the mechanic arts, the case is otherwise — these commonly advancing towards perfection in a course of daily improvement, from a rough unpolished state, sometimes prejudicial to the first inventors; whilst philosophy and the intellectual sciences are, like statues, celebrated and adored, but never advanced; nay, they sometimes appear most perfect in the original author, and afterwards degenerate. For since men have gone over in crowds to the opinion of their leader, like those silent senators of Rome, they add nothing to the extent of learning themselves, but perform the servile duty of waiting upon particular authors, and repeating their doctrines.

The end of our new logic is to find, not arguments, but arts; not what agrees with principles, but principles themselves; not probable reasons, but plans and designs of works — a different intention producing a different effect.[1]

Finally, the preparation of the physical man, like the preparation of the foundations of any great architectural structure, is a first and a last essential. Of little value is a noble conception or a high aspiration, the noblest work of the greatest architect or the highest attainments of the greatest human genius, without a solid and safe substructure, capable of supporting it at all times, in all weathers and in all contingencies, throughout a long and constantly satisfying life. Health, strength, vigor, ambition and high spirits are essential stratums in this foundation of every human structure of character and value. The human mind, the human intellect, the spiritual and the moral man, can only survive and properly flourish within a wholesome and vigorous body. So closely are the mind and body related that the failure of the one carries with it, inevitably, loss of efficiency and ultimate failure of the other. Every minutest defect of body and brain of the physical man detracts from the possibilities of

[1] Novum Organum.

accomplishment of the highest and best in the profession, in the home, in the house of one's friend. No man can do his very best as an intellectual, moral, spiritual being without employing his physical part in its very best estate in the work. Defect of body means, always, defect in the work of the man, either in quality or in quantity.

The physical frame is a machine, a transformer of natural energies. It is at once a home for the soul and a wonderful, an intricate and mysterious prime mover, an engine of which the motive forces are as yet undetermined and unmeasured. We know that its perfection is essential to the perfection of the humanity which it incloses and of which it is the vehicle; we know that the display of the intellectual and the spiritual power, the genius, of humanity is dependent on the provision of ample stored physical energy and of efficient means of kinetizing and applying it to the purposes of the mind as well as of the body; we know that the animal machine is not a heat engine; we think it is not an electrical generator; we are coming to believe that it is some form of chemical motor — possibly one in which the vital, the physical, and specially the chemical and electrical, energies find common source and origin in a common point of emanation. We know that, whatever its nature as a motor, it has an inherent efficiency far superior to that of any heat engine yet devised and constructed by man. We know that it requires certain well ascertained elements as its fuel — or food — that it must be kept well within the requirements of certain well established physical laws; that, to maintain and promote its best and highest work, it must be cared for with scrupulous attention to certain definite hygienic laws. We know that the best possible, the highest possible, can only be attained by man when this curious and mysterious and inseparable vehicle of the soul is thus maintained in its best estate.

The building of the body — which means the building of the brain, always, and just as absolutely — the construction of the physical side of the man, is actually a problem in architecture and engineering and one, like all such problems, capable of a *good or a* bad or an indifferent, but never of a perfect, solution

in any actual case. The building is carried on by mysterious and unknown forces within it, and we can never touch them or their work without embarrassment or injury to both. We do, however, know positively certain laws and their action and certain rules of procedure in the adjustment of exterior conditions, favorably or unfavorably, and in supplying the necessaries of wholesome life. We know, in a general way, what should be the methods of life, of diet, of exercise, of use of powers of body and of mind. We know enough to make the difference, in most cases, between health and disease, success and failure of the physical man, and, in consequence, thus largely to determine the success or the failure of the real, the intellectual and spiritual, man.

The materials of the builder and their preparation for use are, on the whole, well known, for best construction, and it is well established that a frugal yet ample supply is essential of those substances which furnish in potential form the energy which is demanded by the animal machine. Specially should we avoid such kinds as will clog the machine and impede the evolution of the potential energies in kinetic form. These constitute main conditions of production and of maintenance of the maximum efficiency of the machine, and also of its passenger, the inner man, with whom, even in our individual selves, we have so uncertain and so mysterious an acquaintance.

Man has learned by scientific methods to identify and utilize a vast number of materials distributed among the various kingdoms of nature, and the physician and the surgeon are able to perform wonders in the maintenance and repair of this mysterious motor. Plainness and simplicity of diet, frugality and maintained efficiency of the apparatus of preparation, are thus requisites for highest attainments, whether in physical or in intellectual and moral and spiritual realms, whether in gymnastics, in learning, or in imagination and in spiritual life. The famous athlete, the great man of science, the philosopher, the poet or the divine, each and all live a better life and are more perfect men in proportion as they perfect the physical side.

Methods of life and habits of body and mind exercise an enormous influence on the health, happiness, capacity and

achievement of the man. It is the daily experience of every one that only when the body is at its best can the mind and the soul rise to highest levels. Keep the animal machine in good order and the highest efficiency of the being dwelling within it is maintained; and only thus can efficiency be attained or maintained.

The teachings of comparative physiology, indicating what are the desirable and what the undesirable materials of construction, and the teachings of the natural instincts which, in the child as in the animal, reject harmful substances, give ample instructions to him who seeks, honestly and earnestly, for such knowledge. Guided by these precepts, an ambitious and intelligent man can usually find his way safely and successfully through the snares of this world which everywhere trap the foolish and unwary.

With ordinarily good physical health and a good body within which to dwell, at the outset, the way by which to an approximation of the ideal perfection of Agassiz, the "soul of the sage in the body of the athlete" is open to every man. No aspiring and earnest youth need doubt which is the proper course. The way toward the ideal, the perfect, man, is open to him.

The prerequisites of a successful life are health, strength, intelligence; power of self-control and of self-direction; selection of that profession, or that vocation, which gives largest opportunity for the peculiar talents and ambitions of the aspirant; a good general education; a complete professional training; habits of work and play in due proportion; ability to keep abreast of the times, socially, professionally and generally; capability of meeting and of making mutually helpful all people with whom the accidents of life bring one in contact in social or in professional life; and a good-tempered persistence in making a record that shall, with its steadily lengthening and strengthening chain, become a constantly more and more helpful factor of all success.

Professional success attained, the greatest problem, that of making that success in highest degree valuable and productive, is one which appeals to the thoughtful man more importunately than ever could the problem of gaining a triumphant success in any division of the great world of humanity. It is not so much the acquirement of wealth, whether of money or of wisdom or of

fame, which must compel thought and anxious sleeplessness, as it is the problem of investment and of securing safe and satisfactory returns on the accumulated and invested capital. If the capital consists of material wealth, the question how to use it for the highest and best purposes becomes a serious one, and the example of the great philanthropist is studied to ascertain the outcome of his endeavor to do most and best with his surplus, to learn how far such attempts have hitherto proved successful and how far they have proved unfruitful or harmful. If the capital is personal fame and power and influence, the same question comes up in a modified form, and the successful man is fortunate, or unfortunate, after all, proportionally as he is able to make his fame and power and influence felt for good in the great world's movements.

The ultimate measure of the man, of the woman, is the degree of final approximation to the success of a Peabody in promoting education, of a Carnegie in giving men opportunity to learn and to develop, of a Booker Washington in promoting the advance of a race, of a Roosevelt in advancing the standard of honest and patriotic politics, of a Rockefeller in discreetly seeking out the greatest needs of humanity and providing for their effective supply, of a Vassar in promoting the special care of women in their intellectual life, of any approximation gained for self and others to a higher life in wisdom and learning, in knowledge and culture.

The prerequisites of success are the perfect training of the body, brain and soul; the methods are scientific, in education, in training and in practice. The resultant form is a specific type, a species. The results of the work are as specific, in every profession; usually measured, crudely, by accumulated capital, in form of learning, of skill, of property; but its use is ever the same, its abuse usually common to all forms. Its use is the elevation and upbuilding of humanity, its abuse self-gratification; its glory is seen in the progress of mankind.

Tuesday afternoon

SECTION MEETINGS

Section A. PHYSICS AND CHEMISTRY

A SECOND YEAR COURSE IN PHYSICS FOR THE HIGH SCHOOL

BY PROF. ERNEST R. VON NARDROFF, ERASMUS HALL HIGH SCHOOL, BROOKLYN

Mr Chairman and Members of the Physics Section: I think we all feel much gratified by the progress during the last 15 years that physics has made in the secondary schools. Not merely have a great many schools added physics to their curriculums, but the manner of teaching the subject is in some respects greatly improved. Where formerly the dependence was mostly on the textbook, we now see well equipped laboratories and often, in addition, an ample set of lecture apparatus in the hands of a skilful teacher. But these new facilities carry with them certain drawbacks. When out of five periods a week, two periods are devoted to laboratory work, and one to the experimentally illustrated lecture, there are left only two periods in which to discuss all that was discussed in former years, together with the added material presented in laboratory and lecture. The natural result of all this is that, in order to do good work, we find it necessary to cut out an immense amount of most interesting and important material. Indeed, there is scarcely enough time in two periods a week for one year to do much more than thoroughly discuss the work of the laboratory and the lecture. And now in addition to this neglect of the old good things, is the enforced neglect of the new good things. We are utterly unable with the time at our disposal really to teach anything of modern discoveries and inventions. We may perhaps rush in a few of these—the dynamo and telephone, wireless telegraphy and Roentgen rays, etc., but there is no time to give them more than a superficial discussion.

Well, the boy who wants more may possibly go to college. How will he fare there? Generally pretty poorly. Very few colleges offer more than two years of undergraduate work in *physics*, and the work of the first of these years is generally

based on the assumption that the pupil has come to the subject for the first time. Even in several of our larger universities the first year of physics is a superficial course of only three hours a week without laboratory work. And most disappointing in this regard are the poor opportunities offered by the technical schools. There physics is narrowed down to its technical aspects—electricity means generators and electric measurements, heat means the steam engine, light means optical instruments and sugar analysis.

I believe that every teacher of physics should be a physicist. If we are to impress our pupils with the beauty and grandeur of nature's laws, we ourselves should be familiar with that beauty and grandeur. Now, how shall a young man properly equip himself to be a good physics teacher? Or, suppose a boy has grown enthusiastic over his study of physics, and longs to devote his life to it; what advice can we give him? If it were almost any other subject, as Latin for example, it would be easy enough. Let him take four years of Latin in the high school, four more years at college, and several years of postgraduate work. If, added to this, he can supply native talent, he has a good chance of amounting to something. With many other subjects he would have an equally good opportunity; but with physics it is only intellectual starvation. The present state of affairs is a disgrace to the scientific spirit of this age. A boy, starting out to be a physicist, should have fully as good an opportunity to realize this ambition as with any other ambition fostered by our schools. Just as he may elect at high school three years of Greek, or of mathematics, or of history, so he should have the privilege of electing three years of physics.

Of course, we can not expect to secure this immediately, but I believe the time is ripe for at least a second year of physics as an elective. What a glorious fund of suitable material is ready at hand—polarized light, the diffraction of light, spectros copy; the properties of vapors and solutions; the energy relations of heat, the spheroidal state, and radiant heat; the acoustics of musical instruments, and the phenomena of high frequency sound waves; the laws of electrolysis, the laws of electromagnetic

induction, the mutual action of currents, the properties of Hertzian waves, Roentgen rays, and radium rays; surface tension and the general subject of vibration and wave motion, etc. What broad fields lie before us! Without taking up a single idea that is advanced in the sense of being difficult, or merely mathematical, there is enough of important material to keep a high school boy busy fully four years.

How shall we get this second year of physics? I believe that in this world we can get practically anything we want. The only condition is that we shall really want it, and that, wanting, we shall go to the trouble of asking for it—asking for it persistently and wisely. Those who hold position above us are ever ready to do a good thing, but they wish to be assured that it is really a good thing that we ask of them, and that we are thoroughly in earnest.

What is the outlook? Partly unfavorable and partly favorable. Many colleges do not accept two years of physics as part of their entrance requirements. This must be remedied, for we can scarcely expect a pupil to endanger his college entrance by devoting extra time to a subject that will not count. On the other hand, several universities do accept two years of physics; and yet with some of these the terms for the second year are rather unreasonable and almost prohibitory. For example, Columbia and Harvard demand for the second year a course that shall include at least 60 experiments. It seems to me that, if we feel crowded with 40 experiments of a very elementary and crude character, we should feel ourselves in a worse plight with 60 experiments of an advanced and precise character. It is likely that a course carried out on such a basis and with the standard time allotment of a period a day, would mean little more than going through motions. It would in fact be more reasonable and more likely to produce a balanced course to demand *fewer* than 40 experiments. This is another matter to be remedied.

However, very much in our favor is the definite expression with regard to two years of a science made by the committee on college entrance requirements of the National Educational Association. In resolution 10 the committee reports as follows:

That in general we recognize in schools the admissibility of a second year in advanced work in the same subject, instead of a second year in a related subject; for example, two years in biology instead of one year in biology and one year in chemistry, where local conditions favor such an arrangement.

I presume that in localities not favored by a superabundance of funds the cost of apparatus for a second year of physics would appear to be a considerable obstacle. It is true that for advanced experiments expensive pieces of apparatus are often necessary. But, as an offset to this, we must bear in mind that the pupils, having already passed through the subject once, may with very slight inconvenience take up their laboratory work at almost any point. This consideration, together with another, that for the first few terms the classes will not be large, makes it evident that it will be unnecessary to estimate on more than one set of apparatus for each experiment, instead of on as many sets as there are pupils in the class, a practice common with first year physics. Besides, having secured a few standard pieces of a high order, a teacher who understands the use of tools will have little trouble in arranging a generous set of excellent experiments.

Lastly, how shall we begin our campaign? We ought to get our ideas into a very definite shape. Perhaps this can best be done by the preparation of an outline of a course suitable for a second year of physics in the high school. This outline ought to be prepared with the cooperation of the colleges, with a view to their acceptance of it in their requirements. When that much is accomplished, we ought to endeavor to have brought about a uniformity in the undergraduate courses of the colleges throughout the country, and a correlation of these courses with those given in the high school. Then, when a boy enters college with one year of physics, he may go on from that point without having to repeat with no greater thoroughness what he has already done. And, if the boy enters with two years of physics, he may immediately go on with the third year in college.

In conclusion I should like to say a word regarding my own experience with a second year of physics. A few terms ago, when we began, the classes were very small — the first term

the class had only six pupils. The numbers have increased till last term our class numbered 17. Were it not for the matter of counts at graduation and college entrance, this number would soon be doubled. In fact, the interest taken in the second year is considerably greater than in the first year. Of course this is partly due to the fact that only interested pupils elect the second year, but it is largely due to the fact that the subject of physics itself grows more and more wonderful as we pursue it more and more deeply.

Section B. BIOLOGY

The section was called to order by J. E. Kirkwood. He stated that Miss Elizabeth M. Meserve, of Utica, who was to give the first paper, was detained at home by illness. Her topic was "Shall the Extended Work in Botany be made Equal to the First and Second Year of College?" As her paper was not at hand, Professor Kirkwood presented his paper.

THE VALUE OF RESEARCH IN BOTANY

BY PROF. J. E. KIRKWOOD, SYRACUSE UNIVERSITY

It is hardly necessary at this day and age to discuss the merits of research for its own sake, in any science, but I take it that our interests may be properly directed to the value of research work in botany from the standpoint of the teacher, or, as perhaps it would be better put, the value of research work in botany as a training for the botanical teacher. This, it would appear, is a pertinent subject at the present time and one which deserves more attention than is bestowed on it. The question might be put in still another and more general way: Is the work of investigation the method of preparation best adapted to fit the teacher to enter on the work of teaching in colleges and high schools, and, having entered on it, is it the best means of increasing his efficiency?

I had hoped that the discussion of this important question would be assigned to some one better qualified than myself, by reason of a larger experience and a broader knowledge, to set forth the merits of the case; but it shall be the aim of this paper to be suggestive rather than didactic, in the hope that it

may, by inducing discussion, bring out the thoughts and ideas of others.

Inasmuch as the purpose and advantages of botanical instruction are essentially the same, from the pedagogic point of view, as those of other branches of natural science, what is said here in regard to the merits of research work will in a measure apply to the other branches as well. If we bear in mind the end and aim of science teaching at the present time and the requisite qualities and qualifications of the science teacher, we shall be in a better position to consider the best means for his preparation.

Where it is not a required subject in the curriculums, students may elect botany from a desire to know something about it or through a love of it from a previous acquaintance with some of its phases. Aside from the mere acquisition of facts, the names of plants, some degree of familiarity with their structure, habits and relationships, which is well enough as far as it goes, we must not lose sight of the fact that the means used to obtain this end, if properly employed, afford results of far greater importance. I need not at this point dwell on the value of botanical study as a means of training the inductive faculties, nor on the importance of that mental virtue which is shown by the ability to investigate and interpret the concrete. The ability to classify facts and to recognize their sequence and relative significance is still of less importance to the world at large than is the habit which the practice forms. The habits of thought or the scientific frame of mind acquired in the study of modern science will be carried into other walks of life, into the solution of social, economic and moral problems. Professor Pearson states the position admirably in the following words: "Modern science, as training the mind to an exact and impartial analysis of facts, is an education specially fitted to promote sound citizenship." Then it appears that the office of the teacher of botany should be that of a guide to the knowledge of the subject, rather than a mere source of information; one to emphasize the method rather than the material of his science. In view of the end and aim of botanical teaching, the qualities

and qualifications of the teacher are apparent. He must himself be a student, and master of the scientific method. The prime requisites of the successful teacher everywhere may be stated as follows: (1) a teaching personality, (2) scholarship, (3) proficiency in the arts of teaching. As to the teaching personality nothing need be said here. It is an innate quality and can not be acquired, therefore it is outside the influence of research work in the training of the teacher.

Having thus pointed out the aims of the work and the requisite qualities of the teacher, we may now consider the question as to how these ends are to be achieved by research work. We may consider first the value of research to the student who is contemplating teaching as a profession, and here I have reference particularly to the graduate student who is presumably a candidate for the doctor's degree. The majority of the candidates for the doctor's degree in the biologic sciences eventually become teachers either in colleges or secondary schools; we may add also that in the majority of cases both the candidates and the faculties which grant the degrees regard the course of study which the candidates have pursued as ample preparation for the work of teaching. On obtaining the degree, the intending teacher, if he is so fortunate as to find a position, enters on his vocation. Whether or not he is prepared at this time must be determined largely by the requirement for the degree as laid down by the university where it is granted.

It is generally true that the doctor's degree is given for a course of study involving a considerable amount of original investigation. So much stress is usually laid on this feature of the work that the candidate is impelled to give all possible time to it to the neglect of other things. So it comes about that the training of the teacher at the university amounts to a course in research and in little else. Unless he has acquired an extensive general knowledge of the subject prior to his registration for the degree, he is not likely to have it now, and the result is that he usually finds himself face to face with his professional work with little preparation for it. He has acquired an elaborate special knowledge of some particular phase of the subject, but is deficient in any broad knowledge of the science or

of cognate subjects, to say nothing of the pedagogy of the subject which he proposes to teach. He finds, when he comes to teach, that he still has his preparation to get. He has devoted most of his attention to the preparation of a thesis. For this often an immense amount of time has been consumed in the mere mechanical work and technic of investigation, which have afforded no particular educational value. The educational value of the research itself is lessened by the pressure under which he is often obliged to work. If a poor man, the amount of time that he can spend at the university is necessarily limited, and the desire to obtain his degree and find a situation often leads to the temptation to conclude his work with hasty and incomplete results. It has been well said that "it may take several years for this misfit teacher to adjust himself to his proper environment and discover that it is worth more to be a good neighbor and a useful man in the community than to be known in Germany."

It is not our intention or desire to depreciate the value of research either for discovery or training. The position taken is simply this, that research work as required for the doctorate is in itself an inadequate preparation for the work of teaching. A thorough general knowledge of the major and kindred subjects ought first to be obtained and the research requirement not omitted, though perhaps the quantity somewhat lessened. Too early specialization is largely the outgrowth of a demand which is in itself just, viz, that the botanist, to gain recognition as such from the botanical fraternity, must contribute something of value toward the development of his chosen science. It would seem to me that early specialization is not so much to be deplored if the investigator intends to give his life to that work alone, for his time at best is limited, but that the work of the teacher would be better by reason of the broader scholarship. This is specially true of the college teacher, under whose direction must come the more advanced and more technical parts of the work.

Knowledge of subject-matter is one of the prime requisites of a successful teacher, yet in some parts there is a tendency

to subordinate scholarship to method. It is probable that more failures in teaching are attributable to ignorance of the subject-matter than to any other cause. This is not inconsistent with what was said above, that the teacher should emphasize the method rather than the material. It matters not so much that the student be in his earlier work made familiar with a large quantity of material as that he employ the truly scientific method in the study of what he has. Nevertheless, the most efficient teacher, other things being equal, is the one whose grasp of the whole subject is the most comprehensive. Nor, on the other hand, can we agree entirely with those who maintain that, if an instructor is conversant with his subject, he can successfully teach it. Such a conception accounts for much of the poor teaching done in colleges and universities. It suffices not for the teacher that he supplied himself with a knowledge of methods to the neglect of the facts of the science. Strength and ease in the presentation of the subject can not come without familiarity with the science (though they do not always come with it), and such familiarity can come only with the possession of an ample store of knowledge. When a comprehensive knowledge of the facts of the science has become practically a part of the teacher's own mind, it will contribute far more to his efficiency than any elaborate pedagogic theories.

It is, then, hardly possible that the teacher, working under the present research method in the university, supply himself in any reasonable time with a scholarly equipment that should be his when he enters on his life work. The time allotted for preparation is entirely inadequate to the obtaining of such scholarship by research excursions into every branch of the science.

If, then, the early research work is not calculated to produce the best scholarship, in what may we look for its advantages? Where will its beneficent results be shown in the preparation of the teacher? I would say in the arts of teaching. I hope I shall not seem inconsistent with my previous position in urging the advantages of research in its influence on the character and efficiency of the teacher. They can hardly be overestimated.

The teacher's training, it is needless to say, does not end when his active work begins. He is adding to his preparation by continued study and experience. He must grow with his years in scholarship and in character. If he allows the routine of his duties to absorb all his time, he inevitably degenerates from the teacher into the pedagogue. Says Professor Chittenden, "The teacher of science who is content to devote himself entirely to the exposition of that which is known will never make an ideal teacher." He must always, as far as the time is honestly his, be an investigator.

The successful investigator must necessarily have reached the outposts of knowledge in the particular lines in which he has worked, and the presentation of the subject in his classes will receive a vigor and breadth of treatment hardly attainable by any other means. Not so much from the knowledge obtained as from the method of its treatment. He is better able to draw sharp distinctions between what is established and what is theoretic, he is less dogmatic, and his treatment of the subject fresher and more attractive if he is contributing to its progress. If any of his preparation has been the carrying out of a piece of research work to a satisfactory conclusion, he must have mastered in a measure the scientific method of study. He has become familiar with the procedure by which he has first grasped the facts of the subject, then the principles deduced from their proper classification, followed the development of the subject through a voluminous literature and brought all into the proper relation in the completed work.

No research in the true sense of the term can be conducted without the attempt at a fair and impartial judgment of facts, and no one can continue to investigate in this spirit without its influence being manifest in his own character. From his knowledge of the known as a vantage ground he must push off into the unknown. He is no longer passive but active; he becomes participative in activities where he has hitherto been a spectator; launching out on his own responsibility, he assumes new relations with the world of science. All this tends to the development of moral courage and of endurance. In the reward of *patient research, there* is a feeling of confidence which

begets strength, at the same time it enforces humility and discourages arrogance. When an investigation beset by obstacles is carried through to a final conclusion, there is at least the sense of having achieved a definite and worthy purpose. The satisfaction of having solved some problem before unsolved, of having contributed to the knowledge of the world is a stimulus to the productive powers. By overcoming unexpected obstacles in the work he is trained in resource and self-reliance; by the classification of the facts and in bringing into proper relation with his own work the work of others, he is trained in critical ability and coördination; in the placing of his own work in proper form for publication he is trained in construction and expression. In proportion as he studies aright does he become possessed of a scientific frame of mind. He acquires that wholesome skepticism which applies to all things the test of reason. In this I mean the spirit of inquiry which seeks the explanation of phenomena in facts and will not be satisfied till it is found.

It is the carrying of the research methods into the work of instruction that is the most direct and noticeable result. In the laboratory exercise, in the lecture, in the demonstrations and discussions, its influence is felt. As the most logical method it is the most effective and productive.

The presentation of facts and principles in the classroom will be successful in proportion as the scientific method is employed. There is here, therefore, the demand for a mind which is capable of correlating facts and presenting them in the clearest possible manner. More in this line is demanded of the teacher in secondary schools than of the college professor. College students are to some extent able to sort over and rearrange a mass of material thrown down before them. To younger students the subject must be presented with the bearings and relations of its facts and principles more clearly apparent. In one direction is the scientific frame of mind manifest in the teacher's independence, freedom, we may say, from the rule of the book. With the primary sources of botanical knowledge all about him, he seeks for truth in nature rather than the printed page. It is again obedience to Agassiz's old motto "Study nature, not *books*." It is less of the book and more of the laboratory, less

of pedantry and more of those influences which enlarge the sympathies and broaden the mind. They are "iron-clad in bookishness" said one of our well known professors of botany in his characterization of some of the present day science teachers. While it is true that the teacher of botany can not have at his disposal the time or the means to verify by actual experiment any considerable fraction of facts contributed by authors and must of necessity take many things on authority, yet this will be cautiously done. To one who searches out the literature bearing on many problems of biologic science, the dangers of relying on authority will be apparent in the varying and conflicting statements which he will meet in the contributions from even authoritative sources.

What, now, may be said of the influence of research outside of the more subjective phases which we have just been considering? What is said here may apply more particularly to the college teachers than to those of the high schools. American universities and colleges are adopting more and more the German practice of inviting to their professorships only such men as have achieved some distinction through their personal contributions to knowledge. As the prestige and power of the university are in direct ratio with the degree to which it becomes a center for the dissemination of learning, so the reputation and influence of the professor are largely measured by the extent of his productive authorship. While there is as much need in the high schools as in the colleges for the investigating teacher, there is a probability that, if he becomes well and favorably known by his researches, he will soon be called to the college work.

It is evident that the usefulness of the college teacher is largely dependent on the extent of his reputation in his chosen science, not only as shown by the number of students who come under his immediate direction but also by the influence which he wields outside of the university. The efficiency of his teaching will be largely due to the confidence and enthusiasm which he has been able to create in his students; this confidence and enthusiasm *may* be due to the reputation which he has as an investigator. There are some professors, not investigators, who are able by reason of a contagious enthusiasm to bring a

considérable number of students under their influence, but the fact that the student under such an influence rarely gains a correct perspective in his view of the subject robs their work of what ought to be its chief pedagogic merit. The teacher who fails in this end fails in his duty to the student and to society.

In conclusion, therefore, it would seem that the interest of the botanical teacher would be best served, first, by the acquisition of a proper and comprehensive view of his chosen science to the end, scholarship; and, secondly, by the application to research as a means of broadening, refining and elevating his mental faculties, that the arts of teaching may be more effectual. In this way he not only achieves a personal advantage but also serves society more efficiently.

Dr C. S. Gager—The preparation of a science teacher does not seem to me to require the pursuance of research work that concerns itself with the investigation of absolutely new truth. The term "research" may be applied in a relative sense to work new to the student himself, but not new to science. The subjects for investigation may just as well deal with facts of practical value in his life work as to comprise some very limited field of knowledge which will never be of use to him. My opinion differs quite radically from the paper on another point. Failures in teaching do not seem to me in any large degree ascribable to ignorance of the subject-matter to be taught. The lamentable lack is in methods of teaching. Cases are very common like that of an elementary biology teacher in this State who has a doctor's degree and who has pursued postgraduate work in two universities. Yet he was, as the saying is, "stood on his head in the waste basket."

Prof. H. J. Schmitz—Lack of subject-matter and lack of method very often work together to make an unsuccessful teacher. Of the two, I agree with Dr Gager that lack of method is the most fruitful source of failure.

Horatio M. Pollock—A teacher of science is certainly a better teacher because of research. It gives him an enduring interest in his subject. He has the respect of his pupils because he has investigated his subject beyond the domain of the textbooks. They are influenced and encouraged to imitate his thoroughness.

Research work need not and should not be so narrow in scope as is often the case. Zoology, for instance, should not be investigated to the entire exclusion of botany. It is taken for granted that the teacher must have power to influence and control his pupils, whatever his training has been.

Prof. A. D. Morrill—Mr Kirkwood's statement as to the prerequisite of research work seems to me particularly well chosen. A broad and thorough preparation of the subject should be assured before research is thought of. There is a considerable tendency so to extend the time allotted to research that some fundamental divisions of the science are crowded out.

The spirit of research, not the fact, is the primary end in the preparation of the science teacher. Its purpose is to give him a point of view. He learns, incidentally, the difference between textbook statements and absolute fact. His own experience helps him to understand the author's difficulty in obtaining knowledge at first hand and makes him charitable and fair in his judgment of textbooks.

Professor Heusted—I do not think, with Dr Gager, that "research" is a relative term. Some professors assign subjects for research which they know have been investigated before and do not make clear to the students that they are going over ground already investigated. This is not true research. The field of the unexplored is large enough to make this practice unnecessary.

Dr Gager—If a professor should assign a problem not really new in the guise of a new problem for investigation, his course would be pernicious to the student and would react on himself. But why would not a student get as much in the investigation of a subject not known to him as from one entirely new? To my mind, a laboratory course may give all of the research necessary for a science teacher in the secondary schools.

At the conclusion of the discussion, the chairman declaring the nomination of chairman and secretary for the next session of the association to be in order, Professor Morrill moved that the election be by acclamation. Professor Stowell, of Schenectady, was elected chairman; and Dr Gager secretary.

Section C. EARTH SCIENCE

EXACTLY WHAT SHOULD BE GIVEN AS LABORATORY WORK IN PHYSICAL GEOGRAPHY

BY PROF. AMOS W. FARNHAM, OSWEGO NORMAL SCHOOL

Physical geography deals with

1 The world as a whole

a Its form

b Its size

c Its motions

d Its position in the solar system

2 The atmosphere

a Its conditions with regard to

(1) Temperature

(2) Moisture

(3) Purity

(4) Movements

3 The waters of the earth

a Inland waters

(1) Streams

(2) Lakes (both great and small)

In considering inland waters from the physical geography point of view, their origin is considered. In New York most lakes are due to the great ice invasions; the remaining ones were greatly modified by those invasions. Many preglacial rivers were more or less turned out of their courses. In some cases their beds were widened and deepened; in other cases their beds were partially or wholly filled with rock waste. Again, physical geography deals with the interrelations of inland waters, streams to lakes, and lakes to streams. It also deals with them as great erosional or corrasional factors, reducing their basins to lower levels.

b The sea or ocean with regard to its

(1) Extent

(2) Movements

(*a*) Waves

(*b*) Tides

(*c*) Currents

...g and climate-modifying energies

...n of the various relief forms

...velopment of the various relief forms

... influence of relief forms on each other; as the ...fluence of mountains on certain plains and valleys, with regard to the temperature, rainfall, drainage, and soil of these plains and valleys.

c The climate relations of dry land to sea, and of sea to dry land

5 The life of the earth

a Plant life

b Animal life

c Human life, in their relation to, and as influenced by

(1) The atmosphere

(2) The waters of the earth

(3) The dry land

The science of physical geography is based on facts obtained first-hand from the earth itself. These facts have been gathered, recorded, and systemized, from the time of Job, down through the ages, to the present. The true way, the most satisfactory way, the ideal way to study physical geography is to study the earth itself. "Speak to the earth, and it shall teach thee." But human life is too short, and the story of the earth is too long for any one generation to read it in nature's book, recorded there by earth forces. Geography work done out of doors for purposes of study and discovery is called field geography. Since conditions are not favorable for us to pursue this study with our classes in the field, or even alone with ourselves, we must, then, turn to the literature which scholars and teachers of geography have recorded for the faithful and the elect. The literature of geography includes the textbook of geography. Teaching physical geography by the use of literature alone, may be called the library method. The library and the field, each used independently one of the other, are antipodal methods; but, used together, each to interpret and supplement the other, they are *then each the correlative* of the other.

But there is a third means of gaining knowledge of physical geography, a means intermediate between the field and the library. It is the laboratory. Here is the place to test some of the statements learned in the library; to reduce to practice certain theories; to illustrate many facts; and to make the knowledge of geography experimental in a greater degree. The work of the laboratory employs the hand. No science teaching today leaves out this agent in the process of learning. And now, having very briefly outlined the scope of physical geography, called attention to the three different means of geography study and shown the relation of the laboratory to the other two means, we are prepared to consider the subject of this paper, namely, "Exactly what should be given as Laboratory Work in Physical Geography?" Let me say here that this subject was worded for me. If its wording had been left to me, I should not have dared to use the word, exactly. Exactly what should be given, depends on the grade, the time assigned to the subject, the relative times given to atmosphere, water, land, and life, and, what concerns us most, the facilities and opportunities given us by the different institutions in which we work. But, whatever our limitations are, there is still room for much profitable laboratory work. There is but little elementary laboratory work to be done on the earth as a whole. The problem of Eudoxus may be used to illustrate the sphericity of the earth; the problem of Eratosthenes to illustrate the size of the earth; and pupils may be required to construct diagrams to show the position of the earth in the solar system. This work of necessity must be copied work. But copied work calls attention to many facts, tends to reveal some of the relations of those facts, and to fix facts and their relations in the mind.

The first great geographic element which we may consider for study in the laboratory is the atmosphere. The atmosphere can not be studied with as great profit in the field or the library, though field observation and library research should illustrate and direct laboratory work. We have noted that physical geography deals with the conditions of the atmosphere with regard to temperature, moisture, purity and movements. These *conditions* constitute the weather. Weather materials are gen-

eral, abundant and constant. They are always at hand, and never somewhere else when one wishes to use them. They may be studied by all grades, at any time of day, and on any day of the year. The youngest child in the school has some knowledge of the weather through his own experience, hence an interest in it. The oldest child in school can learn something more regarding it. The weather, changing almost momently, furnishes a new phase for every lesson. Monotony is not one of its qualities. The weather affects local industries, social appointments and determines local pastimes. It is the stuff that climate is made of. A knowledge of local weather is necessary for the understanding of local climate; and local climate is the only means to an understanding of the climate of more remote regions. There is no more important geographic element than climate. "The climate of a region is the sum of its weather." Heat is the most important weather element. It determines the relative amount of moisture which the atmosphere is capable of containing. Heat and moisture determine the relative density of the atmosphere and, therefore, its movement. The degree of heat or cold is measured by the thermometer. The moisture or humidity is measured by the hygrometer; amount of precipitation by the rain gage; density, hence pressure, by the barometer; velocity of atmospheric movements, winds, by the anemometer; and direction of the winds by the weather vane. These apparatus, so far as the school may be provided with them, should be handled, and their construction and use studied by each member of the weather-study class, so far as their age and attainments will permit. Here library work may be correlated. Pupils may be referred to biographic articles on Galileo, Fahrenheit, Torricelli and other noted scientists who have made valuable inventions to aid us in the study of the weather. The history of the weather bureau should have due consideration and its publications noted. Children in primary grades should make noninstrumental observations; in the grammar grades, elementary instrumental observations; in high school grades, advanced instrumental observations, unless advanced weather study gives undue time to the atmosphere, which would be the case in schools having but 20 weeks for the

whole study of physical geography. The teacher of physics and the teacher of physical geography could help each other greatly here by correlating their work.

Laboratory work on weather should include the observation and recording of minimum and maximum daily temperature, diurnal range of temperature, average daily temperature.

For January and June, pupils should observe and record the absolute maximum and absolute minimum temperatures, absolute monthly range of temperature, mean maximum and mean minimum temperatures, and mean monthly temperatures. Then determine mean annual temperature, mean minimum and mean maximum annual temperature, and mean annual range of temperature.

Similar work on atmospheric pressure, rainfall etc., may be done and recorded.

Laboratory notes furnish material for classroom work, where the correlation of the direction of the wind and the pressure of the atmosphere may be made; also the direction of the wind and the temperature; direction of the wind and rainfall. In connection with government weather maps, wind velocities and atmospheric pressures may be correlated; and cyclones and anticyclones in their relation to one another, and the local weather conditions determined by each, may be studied with marked interest. It will be realized by the geography teacher that no geographic element lends itself more easily to laboratory illustration than the weather; and that no element needs laboratory illustration more than the weather. In leaving this topic it may be added that Ward's *Practical Exercises in Elementary Meteorology* gives plain and valuable directions for laboratory work on weather study.

The laboratory work on streams and lakes should be done on the streams and lakes of the neighborhood after the actual study of them as field work.

In the field, the stream and lake basins should be carefully considered, their approximate forms, comparative sizes, the direction of their length and breadth, and their boundaries regarded as water partings, being noted. Then should be noted

the tributaries of the streams, the angle at which they enter the trunk stream, and the inlets and outlet of the lake. Then the comparative hights of the banks of the stream and the shores of the lakes. The data gathered in the field should be carefully recorded in the observer's notebook. At a subsequent period in the classroom the pupils should examine diagrams of stream and lake drainage, found in any one of the latest half dozen works on physical geography, to learn the conventional lines, shadings and color schemes used to represent streams, lakes, relief, water partings, and any other features that need to be represented in the diagrams. The pupils should not be required to construct the diagrams to a close mathematical scale; "for the letter killeth, but the spirit giveth life." It is geography, not arithmetic, that is to be emphasized at this time.

The work on local drainage should be followed by a study of well selected United States Geological Survey maps, beginning with the quadrangle that includes the school site. In connection with this study, require the construction of a stream profile, from source to outlet, from data furnished by contour lines; also require the construction of a profile of a cross section of the stream basin. The quadrangle studied will suggest the laboratory work that may profitably be done.

By the use of tracing paper, maps of the oceans with their systems of currents and eddies may be constructed with profit. Such work gives greater definiteness of location and form, and fixes the facts in the memory.

Taking a certain area for a unit, squares may be constructed on a single sheet to represent the relative size of the different oceans. In these squares should be written the dimensions of the corresponding oceans. A similar study of continents may be made and represented by a diagram of squares.

After a careful study of the relief and drainage of continents, made from maps in actual relief, models of the same may be made in sand. After this practice, models may be made in pulp, which may be preserved by the persons making them. I find that pupils enjoy coloring these pulp maps, using the color

schemes found in their textbooks. Teachers will find help along this line in Maltby's *Map Modeling in Geography and History,* published by the Kelloggs. Also in Heffron's *Chalk Modeling.*

There are no better helps in the study of relief and drainage than are published by the United States Geological Survey, a catalogue of which may be had on application to the director. These map sheets cost but 2 cents apiece by the hundred, and a person may order a hundred different map sheets. A little book published by Henry Holt & Company, New York, entitled *Governmental Maps for the Use of Schools,* is of practical help to the beginner. These maps furnish studies of the various plains as to their origin; plateaus as to age; mountains as to the manner of formation; typical volcanos; glacial formations; and the different classes of coasts. Sufficient data are given on each map for laboratory work, either in profile drawing or sand modeling.

The Morse New Century maps of the different countries, specially of the United States, may be used to advantage to represent the different regions of leading agricultural products, as wheat, corn, cotton etc.; also the different regions of leading mineral products, as coal, iron, copper etc. These and the grazing regions, lumber regions, and other great industrial regions of our country may be represented by shadings with pencil or brush. The models for this work may be found in any good work on geography.

The stereopticon may be considered as a supplement to field work; snap shots of the local geographic forms as laboratory field work; but the preparation of the lantern slides is laboratory work pure and simple. The stereopticon has become a necessary adjunct to the teaching of physical geography. Pictorial teaching is a strong factor in all teaching. The use of local views in the stereopticon makes unfamiliar views seem more real, and something more than mere pictures.

If pupils were required to make diagrams from pictures, then the diagrams found in geographies would have greater meaning.

The sketching–picturing–of geographic forms is legitimate laboratory work. These sketches often give the pupils geographic concepts more fully than oral descriptions could possibly give. Practice in sketching may be had from copying sketches found in Augsburg's *Easy Drawings for Geography Class,* pub-

lished by the Kelloggs, also in Morton's *Chalk Illustrations for Geography Classes,* published by Flanagan.

It is believed that all of the laboratory work indicated in this paper is practical and helpful, though not a little of it is elementary. The work on topographic maps, however, may be done in the high schools and in all of the higher grades.

In the *Journal of School Geography* for December 1899, Professor Snyder gives an outline of geographic laboratory work under his supervision in Worcester Academy, Worcester Mass. In this outline Professor Snyder gives 52 excellent laboratory exercises. In the same magazine for June and September 1897 are outlines of laboratory work in elementary physiography by Professor Cornish of Morgan Park Academy, Morgan Park Ill. In Professor Cornish's outline is given correlated library work to be done in connection with each laboratory exercise. And herein is the greater helpfulness of Professor Cornish's outline. If laboratory work is done in and for itself, it had better be left undone. If it is done to satisfy the present demand, without a well defined aim, simply that the doer may be in it, then the less of it the better. Each teacher of physical geography must determine the time and place, the character and amount, the relation and purpose of his laboratory exercises. Let him see to it, however, that he so determine. The omission of laboratory work is the omission of a prime factor of geography teaching. The laboratory: the field on one side, the library on the other; a trinity in a unity. And the teacher who does not believe in each, fails to understand fully the purpose of physical geography in the plan of instruction.

Professor Farnham was elected chairman of this section for the next year.

The chairman read a note from Prof. Frank Carney, of the Ithaca High School, stating that illness prevented his attendance.

Section D. NATURE STUDY

INFORMAL SCIENCE IN THE GRADES

BY PROF. WILLIAM HALLOCK, COLUMBIA UNIVERSITY

[Abstract]

Botany, zoology, reading, mathematics etc. are commenced in the lowest grades and reviewed and advanced with succeeding years till, when the high school is reached, the pupils are in a position to do real, substantial work in these subjects. Chemistry and physics are reserved for the high school and then for one year each; and finally we are informed that science teaching is a failure and ought to be abandoned.

This is wrong for two reasons. These sciences are really more fundamental and important than the biologic descriptive ones and certainly in cities can be more readily taught. Secondly, it is inconsequent to try to teach a child plant and animal physiology without some knowledge of physics. How can a child who has never heard of solution or capillary phenomena understand the function of sap or roots and soils etc.?

This should be changed, not perhaps by the introduction of "natural philosophy" periods or the "science of common things," but by the introduction of suitable material and experiments into other courses. It is just as easy to prepare leaflets for these as for nature study, and they will be taught no more mechanically by the average teacher in the grades.

The scholar at the end of the grammar school should have a knowledge of chemistry and physics at least equivalent to his knowledge of botany or even mathematics. Under these circumstances the scholar leaving school then, will know something of the subjects; and those who go to the high school will be able to do work in these experimental sciences equivalent to that in algebra, geometry etc.—real work, not foolish elementary stuff that might almost be taught in the kindergarten.

Wednesday morning, Dec. 31

SECTION MEETINGS

Section A. PHYSICS AND CHEMISTRY

THE PHYSICS MACHINE SHOP IN SECONDARY SCHOOLS

A letter was read from Prof. O. C. Kenyon, in which he stated that he was unable to be present, but sent his paper, which was not read till after formal discussion of the topic.

Prof. L. V. Case—It is a little difficult to discuss a paper that has not been read. I will simply bring up a few points that I have found useful in the laboratory.

A few years ago I found myself in a high school, a fine building, but all of the apparatus in the laboratory was a Holtz machine with two glass plates broken and an air pump with the valves gone. With the assistance of the principal, we procured a set of tools and with the aid of the students constructed several pieces of apparatus, and, through the kindness of Mr Cobb, we succeeded that year in getting our course approved. Since then we have been a little more fortunate in securing apparatus.

In the selection of tools the first year, I believe we put in about $25; and those I found most convenient were, first, the lathe, cost about $8, and with a saw attachment about $1.10 more; next a set of carpenter's tools and a few iron-working tools. The whole cost that year, I am sure, did not exceed $25. Since then I have increased the tools.

In taking up a piece of apparatus, we combine in one the construction of the apparatus and the use of it as well. By far the greater advantage, I think, of homemade apparatus lies in the good it does the pupil to construct it rather than the value of the apparatus itself.

In this little piece which I have brought to illustrate, take the construction. First, the pupil decided on the piece he was going to construct. He procured this little figure; next he wanted to know how high he had to make the stand; and found the distance from this point to the base, from which he worked out the size of piece to use. The student who constructed this never had a tool in his hands before. We are confronted with pupils of a different class from those in the country towns. A large num-

ber of the pupils have never used tools of any kind, and the use of them is entirely new, and they have some difficulty at first in manipulating them at all. Next, in the course of construction, the pupil turned out the little standard on the lathe. Had never used a lathe before, and a little practice was required to develop his architectural ability. Then the figure was too long, and he had to use the saw. Next came the point of putting the pivot in with pliers; having bored the wood, he drilled a hole in this and inserted a brass pivot. Next he had to have something for the pivot to act on and inserted a screw and drilled a hole with the same tool in the top of the screw. Next came another example. He wanted to know how large balls he should use and of course had to construct the balls himself. He wanted them so they would not hang too far below the figure but properly balance. There came in the example of specific gravity. He weighed the figure, and, after weighing the figure, it was an easy matter to compute the size of the balls, knowing the specific gravity of the lead. Next came the manual training in modeling. He first turned the balls out from wood and then made a model of plaster paris and filled them in with lead and finally polished the figure and drilled the holes. Of course, this is one of the simpler pieces, but it shows what we can get out of a single piece of apparatus.

This piece of apparatus [illustrating with another piece of apparatus on the table] was constructed from what we have in the laboratory at this time. The student was one who had a great deal of trouble in grades but had managed to enter the high school. We got him interested in the subject of physics. This year he is doing excellent work in the Pratt Institute. The apparatus is simple, only a little motor, and the pupil, after finishing the piece of apparatus, knows more, I am sure, of the apparatus than he did at the beginning.

Prof. William M. Bennett—It seems rather ungraceful and improper to talk about a paper before it is read. I fear my ideas may differ from those of the other teachers. I am much interested in what has already been said and can readily perceive how pupils placed on that work can obtain a great deal of advantage from it. Possibly I am alone in thinking the idea of pupil work in the shop connected with the physics laboratory should be taken *with considerable* modification, for two or three reasons. In

the first place, the advantages of this work in the machine shop, I can see, might be under three heads: the gaining of apparatus for the use of the school; the value of the manual training which the pupil might get; and the better understanding of the subject which he might obtain. As to the apparatus obtained in that way I have an idea that frequently the more a teacher is willing to make for himself, or get made by his own exertion, the more those in authority will allow him to make. So, if he is going to get apparatus from some source or other, he can get as much of it, himself, as he has a mind to undertake, and the more he makes, the less he will get from other sources.

I think that, particularly in physics, an instrument should be an instrument of fair precision. The best instruction obtainable under the circumstances is none too good. It sets a better example, the student has a greater reverence for it, and it inculcates a better tone. I can understand that there are many cases where the assistance of pupils in the construction of apparatus would be very acceptable, and anything I might have to say on this head would not apply to all cases alike. I know from personal experience that there are many places where many things are not available, and the only way to get them is to make them or get them made with the pupils' help. As to the manual training, a course of manual training comprising a course of physics, would be an ideal arrangement; one would help the other a great deal. The pupil, by use of his manual training, would have a better command of apparatus and more facility in handling. But I think we have enough to do in a year's work in physics, so that we can hardly spare the time needed to occupy the pupil in the manufacture of apparatus. The teacher of physics has his hands fuller than the teachers of most other topics, and he needs what time he can get to prepare for the regular work. The pupil can get a better idea of physics from the manufacture of apparatus; yet I doubt whether the time thus spent can be well spared from the more exact study of the science. I would not like, by any means, to be understood as thinking that the work is without value; it is and can be immensely valuable if there is time for it, but I believe in many cases there is no good opportunity.

THE PHYSICS MACHINE SHOP IN SECONDARY SCHOOLS

BY PROF. O. C. KENYON, SYRACUSE HIGH SCHOOL

[Read by Prof. George M. Turner]

It is my proposal in this paper to consider how a teacher of science, and specially of physics, may wisely and successfully equip a workshop and conduct in it a class for the repair and construction of such apparatus as may be needed in science laboratories.

It has been urged at meetings of this and other similar organizations that teachers have not the time for this sort of work, and that it should be left to the mechanic by trade. No doubt there are many teachers who ought not, from lack of time, to engage in it, and many also who have little taste or aptitude for it. But my words are addressed to those who, besides having a strong desire adequately to equip their laboratories, have a natural love for tools and machines and are also able, out of the crowded week's time, to set aside from two to five hours for this work, provided, of course, they may think it worth while. A number of years ago, a college professor of physics said to me, that, if he were to begin teaching over again, he would first take a manual training or a mechanical engineering course. Having myself acted on this advice to some extent, I have ever since been grateful. To any person who enjoys the using of apparatus, the construction of it should give an added pleasure and inspiration. Then, too, the possession of a shop renders one somewhat independent of school boards, and these, at times, are not liberal toward the science departments. The following, also, I think is true: the average school board would rather equip a shop for manual work than equip a science laboratory. Besides, a board that sees a teacher so desirous of having apparatus as to be willing to make it, himself, will be more generous in furnishing apparatus. This, at least, has been my experience, and it seems only natural. With a good shop at hand, the repairing of broken pieces becomes easy, and time is gained rather than lost. Who does not find every day something that needs to be repaired or improved? Often more time is wasted in trying to use an imperfect or ill made piece than would be spent in making it over again, if only the best tools and sufficient skill are possessed for

doing it. Improvements in apparatus are constantly being made by teachers and manufacturers; and, as we hear or read of these, we wish to make the improvements. With a first-class shop and a dozen or two willing workmen, very much in this line can be done and without large appropriations. This improving of apparatus with the aim of saving time in experimenting and enabling pupils to reach more accurate results is a fascinating study and worth all the time it takes. To many teachers, it is not an added care, but a pleasant change from classwork, in fact, a recreation. One of the important advantages of a shop is the ability it gives of testing new discoveries and of carrying on investigations without the expense attached to ordering apparatus from the maker. At first one's ideas are apt to be vague, and perhaps several attempts may be necessary before the result desired is reached. For example, since the Wehnelt interrupter was discovered, many forms of it have been suggested. We have tried several, this last form having just been finished by one of my boys. The cost has been insignificant. Without the shop we should not have had the piece, probably. In the same way we have experimented with electric furnaces and now have one convenient and of considerable capacity. Its cost was perhaps $3, instead of the $30 or $40 that the apparatus makers would have charged.

As a contrast to this saving, I might mention a coherer bought in the early days of wireless telegraphy for about $8, whereas a little experimenting in our shop would have given us just as effective an instrument for a dime or two. In fact, after buying the coherer, I found out that one of my pupils had already made a coherer at his home quite as useful as the one I had bought. It is not necessary, I think, to illustrate further the advantages to the teacher and his work of such a shop as that of which I am speaking. Every science teacher must have felt repeatedly either the need or the advantages of one.

But how about the pupils — have they the time and incentives to help in this work? In schools that have no manual course, I believe that this work may be made of more benefit to many pupils than the science work itself. All the results of manual training may come from it: the strengthening of the motor nerves and of those larger brain cells which, as we are told, control and *operate the fingers; the* teaching of the fingers to do just what

we wish them to do, that is, the getting rid of the feeling that "our fingers are all thumbs"; the strong influence toward sincerity of character; the creation of confidence in one's power to reproduce in matter one's ideas; the ability to work to scale drawings; the development of the imagination to plan ahead accurately; the cultivation of the esthetic qualities to some extent, by the finishing and ornamentation of the piece worked out; the growing respect for mechanics and mechanic arts. All these are the well understood effects of manual training, and they also add to the ability of pupils to do science work proper. Only those who have learned how to square a block properly by hand or to turn a cylinder to a scale in a turning lathe can appreciate the variety of the training involved.

But, besides this manual training, in the physics shop there is science instruction also. I have here, for example, a double cylinder, weighted to float in water, which I needed for an experiment on the upward and downward pressure of liquids. I gave the problem a few weeks ago to a boy who had studied hydrostatics, to figure out the amount of lead required for a block of this shape and dimensions. After obtaining his result, he made the block, two or three trials being necessary before a successful result was reached. Now, to his knowledge of the laws of floating bodies, density etc., this boy has added a feeling that he can make use of his knowledge, that he is to some extent a doer of things.

It is a good plan, after a boy has made a piece of apparatus, to give him an experiment to perform with it. After building a wire bridge, for example, like this, let him measure the resistance of a wire with it. I am assuming that this subject is new to him. This experiment, made with apparatus of his own construction, will impress him much more than if done with one in which he has no personal interest. In other words, this sort of work leads to strong and vivid ideas, such as remain with one and mold the character.

It is best usually to assign to the boy a piece with which he is not familiar. While he is making it, refer him to some textbook or to a history of science describing it. In this way, he will come to feel that his work is associated with that of the great scientists and inventors. He may even make some little improve-

ment in an instrument used by Newton, Tyndall or Faraday. And so the spirit of discovery and invention may be awakened.

Again, there is this point to consider, the average boy in our schools does not know for what he is fitted. The study of electricity gives hundreds of boys the idea that they want to study electrical engineering, whereas a few weeks' work in a shop may convince them that they have no taste or aptitude for constructive work, their interest arising only from the novelty of the experiment. On the other hand, many who have never had the opportunity to use tools and machinery discover in such work a keen and surprising pleasure. Such boys are apt to decide in favor of an engineering course in college. Every school should help boys in some such way as this.

I will next take up the question of how to obtain the shop's outfit. The first step in the attainment of any aim is to desire it strongly. Being thoroughly convinced, then, of the importance of a physics machine shop, let the teacher suggest the idea to the boys of his class and see how eagerly some of them will respond. Many will be able to bring tools; they will doubtless agree to a tax for the privilege of working. Ask them to talk with their fathers, uncles and neighbors about it. Obtain the aid of the leading merchants and manufacturers, specially of the hardware and lumber dealers. The latter will no doubt, if asked, contribute materials for the undertaking. Everybody will favor the project. Now ask the school trustees or board for a contribution, this is to be duplicated by the State.

It may be of help to some if I relate a little of my own experience in starting this shopwork. Some years ago it occurred to me that, as we had no instruction here in manual training, and greatly needed it, a class might be started in manual training, which would also help in the equipping of my laboratory. This work was begun in a small storeroom, having only one window, and with a few old carpenter's tools of my own. A few new tools were bought with money contributed by ourselves and doubled by the Regents. We very soon outgrew the storeroom and appropriated the attic, a skylight being made at a place where an electric motor was running a ventilating fan. By extending the shaft and buying a few pulleys and belts, we were able to run tools afterward by power. This was a great addition. Foot

power is better than none, and gives one exercise, but a motor is so interesting in itself, that it is half the battle won to obtain it. Soon after this the board of education gave us considerable money, and a society of women, $500 to advance specially the manual training part of the work. It was only a term or two after this, however, before the attic proved too unsteady to support all our machinery, the noise interfering with the other work of the school. Since then I have to content myself with a few of the smaller drills, lathes etc., the larger pieces being stored to await the growth of public opinion. In our new building I hope to have a physics shop quite complete in equipment and well suited to our needs. The bench work in wood, however, has been extended to most of the grammar schools, and the establishment of a manual training high school should not be much longer delayed. This little matter of local history is mentioned only as a suggestion.

There is no good reason, it seems to me, why regular manual training classes should not help out the equipment of the laboratories. As this is not my subject, however, I will not pursue the idea further, but will proceed to consider what the physics machine shop should possess in the way of tools and how a teacher without a special training in the work may successfully conduct a class in the manufacture of apparatus.

The first tools to buy are a grindstone, oil stones and an oil can. Whether tools are old or new, they must be kept sharp. This is perhaps the hardest part of all. It requires much time and patience for a person to keep several sets of tools sharp. Dull tools, however, are the first cause of failure. Buy at once a book of directions in wood and metal working. One great reason for failure is right here. We are all used to a saw and hammer, and the other tools seem as easy to operate, but to use tools so as to obtain accurate results — there's the rub. Persons who have not had systematic training in mechanical work are apt to overlook the knowledge of science involved, but the manual training people know better, and they have learned the best order in which to teach mechanical work. Therefore by all means buy at once some books on wood and metal working, such as *Bench Work in Wood, Wood Working for Beginners, Wood Turning by Golden, The Practical Machinist*, etc. These will give a list

of the tools required and also directions as to the use of the tools; but the main thing is to follow the directions carefully and minutely. Set each boy to practising the first operation in the book, which may, for example, be planing. Do not try anything else till the first result meets the test, till, for example, the board being planed is really *flat*. Several trials will be necessary. Do the work, yourself, and insist on every one else doing it. Many of the boys will wish to begin with something more interesting, as a dynamo or steam engine, but in no case allow them to do so. Too difficult work leads to unsatisfactory results and is another chief cause of failure. After two or more operations with the tools have been thoroughly learned, pick out from your apparatus some piece of which copies are desired, or else from a catalogue of physical apparatus choose something that you wish and which, in the making, does not involve anything much more difficult than what has already been learned. A large number of the pieces needed in a laboratory are easy to construct, consisting, usually, of a baseboard and a few additional pieces fastened to the base. Of this sort are the Rumford photometers, sonometers etc. Having finished this easy piece, choose next something involving other operations and follow the same course as before. One thing well done will help all the rest, but each step should be satisfactory before the next is begun. As a rule, choose something that is new to the pupil and tell him what it is for. This may be done of course before the practice work is begun. If he is the right sort of a boy for this work, he will be interested and will do his best. When the instrument is finished, have him stamp his name on it. Summing up this matter, I would say, have each pupil follow to some extent the order of the manual training operations; in making a given piece of apparatus, however, it is not necessary to learn all the operations coming before those used, but only those needed for that particular piece. In a shop of the sort I am describing, where there is not much duplication of tools, the class should not consist of more than 10 boys. Each will usually be at work on a separate piece and each step requires help. If convenient, the pupil should be given a model to copy. It is a good plan to buy a sample of the instrument needed, and to make copies of it, one for each member of the science class. The makers, so far as I have learned, do not object

to this. My experience is that the more apparatus one gets, the more one wants. There are hundreds of pieces needed that it does not pay to make. Such are all kinds of graduated standards.

One's desire and the improvement in apparatus reach ahead of any school budget. We should aim, it appears to me, at having a laboratory that will illustrate every important law or principle and also aim at supplying each member of a laboratory class with each kind of instrument being used, so that all may do the same experiment at the same time and also work alone. In large classes there is, in this method, a great saving of the time of both teacher and pupil, over the method of giving each pupil a separate experiment to perform.

The making and using of working drawings is advisable, also, and, if the boy is studying mechanical drawing, each class of work will help the other. But the drawing is not necessary. Concerning the kinds of wood, use those that have a pleasing grain when finished, as oak or cherry or mahogany. As the pieces are usually small, the extra cost is not great. For wood turning, the darker gum woods are excellent, being tough in texture and pleasing in grain. If possible, have a motor, electric or water or gas, of at least one horse power. Of course, two or more carpenters or better, cabinetmakers vises must be provided, together with three or more strong iron vises. The best soldering iron heater is the gas stove made for that purpose, or, if you are provided with electricity the electric soldering iron will be found useful and satisfactory. A foot power or other blower for the blast lamp, for glass blowing or other work, will also be needed. Two wood-lathes and two iron-lathes should be provided, one of the latter having at least a 12 inch swing. The larger lathes are more satisfactory for many reasons, chief of which is that they are less liable to get broken. For a cheap, strong, slow drill, that is for the larger sizes of holes, the form used by blacksmiths is very good and may be worked by hand or motor. For a smaller drill press, Barnes's sensitive drill has proved very serviceable to us. In a larger shop I should ask for a stronger drill press. Also, a power hack saw is an interesting tool, far superior to the handsaw; and right here I may say, what is perhaps obvious, that those tools which are run by the motor will be of most *power* in holding the interest of the class, a point which should

be studied. Any one who has felt the pleasurable thrill that comes from throwing into action a power hack saw, or that from seeing it stop itself when its work is done, knows what I mean. An anvil, a forge, an emery grinder, a buffing-lathe, band saw, circular saw, milling machine, universal grinder, shaper and an iron planer will suggest themselves after the more essential tools have been provided.

So far as my experience goes, it is best that the class should meet outside of school hours, each pupil attending but once a week and for not longer than two or two and a half hours. My practice is to give Friday afternoons and Saturday forenoons to this work. No fees are charged the pupils. All work done is for the school. The pupils admitted are usually of the physics classes, though others are not refused if there is room for them. After a boy joins the class he may remain as long as he chooses provided he is regular and industrious. Three absences without good excuse constitute a forfeiture of membership. Some credit is usually given for this work which helps to raise the physics mark. There has never been a time when there were not more applicants than I could accommodate. In our school there are probably several hundred who would like to take the work if I could accommodate them. It is well to allow pupils to join the shop class as a reward for good work in other lines.

Finally, if we were able to persuade our boards of education that this work is of sufficient importance to warrant their engaging a competent mechanic and teacher to give all his time to teaching the repairing and constructing of apparatus to all the boys of the school who might wish to engage in it, I am convinced that no more valuable course could be found in the school curriculum.

Professor Case—If I might add one more point to what I said before. I have brought a few little pictures of pieces of apparatus the pupils have constructed, that may be of interest to some of those present. A laboratory table equipped with apparatus made almost entirely by the students. The total cost of the apparatus as pictured on the table is, I believe, between $4 and $5 and consists of about 15 different instruments that are useful.

I have received a number of letters at different times in regard to the method employed in obtaining the wave length of sound

by means of a tuning fork. I brought this little sheet with some of the records I use. The method we employ, instead of a bristle attached to the tuning fork, is to attach a pin which has an extremely fine point, attached by means of a piece of sealing wax. The records, instead of being made on glass, are made on paper. We take an ordinary piece of paper and coat the paper with carbon by means of an oil lamp with about $\frac{1}{3}$ kerosene oil and $\frac{2}{3}$ spirits of turpentine. Then, after the records are made, we coat the paper with a varnish and the records are finished.

Professor Turner—I would like to ask Mr Case about fastening that pin.

Professor Case—We take the head off the pin, let it lie between the two bearings inside and finally give it a curve.

Professor Turner—In smoking the paper, can you get that even?

Professor Case—Yes, get it very even. This is some left over from last year.

Professor Turner—Any particular shape to the flame?

Professor Case—No, we use an alcohol lamp.

Prof. W. J. Greene—I wish to add my approval of this work. Mr Case spoke of the boy who was poor in his studies all through the grammar school. I think we need to look out for that boy. He is ordinarily turned out of school as a blockhead. If he is fortunate enough to get into a physics class, he gets interested in tools and becomes one of the best boys in the school. In every school there is one, and more likely there are three or four of these cases. If such work reached only this one it would be valuable. I believe the real educational value of this work is far greater than the accurate determination which the professors want to get out of our high schools. It is more educational for the average pupil who will not go to college. I think he is entitled to consideration; and this is the class where he can best receive this consideration.

Professor Turner—I want to say a word in regard to this paper. I like this idea first rate of getting work out of the boys in making apparatus for the laboratory. I have never carried out the work as thoroughly as Mr Kenyon; but for several years I have had from two to eight boys stay after school at any time I would suggest, and who usually stayed as long as I would allow them to stay. Some of the boys come back after they have been to college

or at work somewhere, and I believe those boys have a very dear spot in their hearts for this laboratory. They see things still preserved that are records of something they have done, and it means a great deal to those boys. I intend to have some boys do the same kind of work Dr Kenyon has spoken of in his paper. What we have done previous to this time has been making small pieces of apparatus that could be done with the saw, file and plane. They were all helpful, and, I know, have brought good results; and I am most heartily in sympathy with that line of work for boys fitted for it, and who will take hold of it.

Chairman Whitney announced the names of a committee appointed to prepare a syllabus for 2d year physics for use in school [*see* p. 458]; also the selection of Professor Babcock of Alfred University as chairman of the section for next year.

Section B. BIOLOGY

EXPERIMENTAL PHYSIOLOGY IN THE HIGH SCHOOL

BY PROF. M. SMITH THOMAS, LE ROY HIGH SCHOOL

When I was asked to present a paper at this association, the subject of experimental physiology in the high school seemed to me a worthy and appropriate topic to be introduced for discussion. I come not to instruct, but to be guided and assisted; I speak not to dictate some model and uniform path from which none shall deviate; I wish simply to present my methods and devices in the schoolroom, trying to give a practical and methodic manner of teaching physiology in our high schools. In this large attendance of scientific instructors, as many methods and devices will be advocated as there are individuals present, each adapting his modes of instruction to his environment and personal preference. Before me I see men who have seen years of service in the schoolroom, who have studied the fundamental principles of pedagogy, and who help to form a portion of the Empire State's able corps of educators. I am positive that each of you has much more valuable knowledge concerning this high school subject than I; therefore I will merely make a few suggestions, telling you how I teach physiology, pointing out the devices useful to me and the method most serviceable in my experience.

In performing experimental work in zoology, botany, physics and chemistry, my classes have always been handicapped in their laboratory work by their awkwardness in manipulation, their ignorance of apparatus and their lack of independence in procedure. Much valuable time has been consumed in learning the names and the adjustment of simple apparatus, in gaining a rudimentary knowledge of chemicals, in the neat and concise arrangement of notebooks, in learning to observe the results of an experiment, in gaining an efficiency to tabulate the causes and effects of natural phenomena and many other annoying and worrying detentions.

On the day of entering the laboratory, everything is new to the pupil. He moves in a strange atmosphere, he has left the monotonous tasks of everyday classroom routine and enters on a course of personal investigation and accurate confirmation. Much depends on the instructor as to whether the pupil likes or dislikes his laboratory work; much individual instruction is necessary and many details need to be properly impressed on the child's mind. His powers of observation and reasoning faculties begin to unfold, and now is the time when this developing mind needs the most careful guidance and the most influential environment.

Two classes of students have come under my observation. The one is the boy who enjoys a glorious Fourth of July, and he easily imagines the laboratory a wholesale Chinese firecracker establishment, and, if unrestrained, indulges in the opportunity to celebrate. At first he is all animation, and some little time must elapse before he is accustomed to his surroundings, and his nervous tension and ungoverned activity subside. Then comes the critical moment. He now tires of the work, if not properly stimulated and if not taught the value of a thorough laboratory education.

The other class of students, usually composed of girls, delay proper advancement in the subject because of their timidity and dependence on the instructor. A fear prevails that some magical power will transform everything they touch into fragments, and very frequently this inference is a truism. This particular kind of pupil needs much individual direction and personal encouragement, till he gains independence in his work and confidence in his *ability to* manipulate and to execute.

Let us begin our experimental work in physiology during the first year of the pupil's high school course. In my teaching I have found laboratory work in this subject an easy stepping-stone to experimental work in other sciences.

The names, uses and workings of simple but necessary apparatus may be properly taught. Let the pupil become thoroughly familiar with such apparatus as a ringstand, a pneumatic trough, a gas-burner, a test tube, a cork borer, a filter, a crucible, a flask, and many other simple contrivances. I would give much drill in the arrangement and construction of apparatus, then teach the use of the complex whole. Lead him to see how important each unit is in order that the entire combination may properly perform its function. Permit the pupil to construct simple contrivances. Urge him to execute his own ideas and to perfect his own mental plans. Lead him to see that there is need of better devices, allow him to look on himself as an inventor and encourage him to work out his rude conceptions.

By the most conservative, laboratory work may be considered a "fad." Laboratory work is beneficial, it is practical. It has come to stay. Laboratory work is the work of the hand directed by the mind. This work is specially attractive to the pupil who has just entered the high school. At this age, many pupils become weary of school work, outside attractions become more inviting, and their lessons are neglected. It is the duty of the instructor to put forth every effort and bring every possible lever to bear on pupils that they may remain in school. Many a boy has left school who afterward would have given all his wealth for a high school education.

Among the boys who sit in our schoolrooms today, are the Edisons and Marconis of tomorrow. Suppose that mischievous boy who is in your class each day has a liking for invention and experimental work, are you going to permit him to drop from his class and go forth into the world to dig ditches for the remainder of his life? Who is responsible for his future success or failure in life's work? To whom does the duty belong to encourage him, to praise his work, and to give him a high ideal? Let us as teachers stimulate in every possible way the American youth to find a high ideal and to do his level best.

Well do I remember my high school course in physiology and the dislike I had for it, aversion which clung to me when I began to teach. Why do pupils approach this subject with a feeling of repugnance? Is it not because of the narrow scope which the textbook and the instructor give to the subject? What interest can a boy who is "alive" take in a conglomeration of names associated with an imaginary body composed of bones, muscles and other tissues? Give him something he can see. Show him that his body is only a unit out of millions; lead him to perceive that the circulation in his body is more highly developed than those of the lower animals, show him the differences, point out the resemblances, teach him to observe nature for himself.

Show him the one chambered heart of the lobster, compare it with the two chambered heart of the fish, examine the arterio-venous ventricle in the amphibian, on the chart, trace the peculiar circulation of mammal's blood system.

Briefly study the digestive, the respiratory and the nervous systems of different animals. Deal with *life,* for where *life* is, *there* is physiology. It matters little whether the living matter occur in man or in reptile, in amphibian or bird, in protozoan or metazoan. The term physiology should be associated with man no more than with other organic species.

After using several varieties of notebooks, I have a notebook which pleases me. At first I used a notebook bound in book form and of small size. The written directions were on the left hand page and an opportunity given to write the results of the experiment on the right hand page. My chief objection to this form of notebook is, that, if an error is made, the page is ruined and it can not be removed. Some will argue that that is the best form of notebook to use, as it gives the pupils true work, but I believe in giving the pupil an opportunity to correct his mistakes. If he makes a blot, misspells a word or makes other clerical errors, see that he corrects them. Teach him neatness, and he will acquire accuracy and painstaking. Engraft these principles into his very being; for not far distant in the future he must go forth from the high school, either into the college or university, or to face the world's contending battles, to write his record in life's book. We as teachers, having the pupil under our

supervision six hours during the day, are responsible to a great extent for his success or failure in after life.

All about us we see business men careless in their mercantile relations, and we say they have a loose manner of dealing and conducting their affairs. Perchance we can trace these habits back to the high school and away down through the grades, to some teachers who allowed them to be slack in habits, slothful in their duties, not neat in their work and inaccurate in their tasks. On every side, we notice young men careless in their expenditures and irregular in their habits, and we say they are living a "fast" life. Who will be accountable for their record? To whom can the rudiments of their misdoings be traced? Is not their high school instructor in a great measure responsible for their wrongdoings? Should not that teacher have directed them into avenues and channels of accuracy, neatness and thriftiness?

In our classes at Le Roy we use a notebook which has a removable cover. Through the back are three small holes at intervals of about 4 inches. We buy the paper by the ream, which is already perforated. After placing the paper within the covers, three rivets, or a shoestring, are placed through the holes, thus giving a very convenient notebook. The chief advantage of this notebook is that, if a page is ruined, it is easily removed, and at any time new pages may be added. We obtain drawing paper of a uniform size, have it perforated and place it in the notebook at any place desired. We have our science notebook of a uniform size throughout all the laboratory branches.

The drawings which are placed in the notebook are first made in light pencil mark, these are traced in black ink. I prefer ink drawings, as they are clean cut, distinct and not erasable. They also have a more finished appearance, and the pupil feels that he has accomplished something and takes a sense of pride in his work. Some of these drawings are finished in colored inks, which greatly adds to their beauty and impressiveness. If it be a drawing in comparative physiology of the circulatory systems of different animals, the pure blood circulation is traced in red ink and the impure in blue. If it be a botanical drawing, green ink and many other colors may be used.

Frequent use should be made of the microscope. Several weeks are necessary to accustom the pupil to a practical use of this

instrument. I would teach him to use the compound microscope independently and skilfully. Teach the names and functions of the parts, and have a drawing made of the instrument. Show the pupil how to focus it, how to use the reflector, when to use the coarse adjustment and when the fine adjustment and, above all, how properly to care for this valuable piece of apparatus. Have the pupils bring physiologic specimens to the class for microscopic work, instruct them how to mount them. When dissecting, examine the different organs and tissues, finding out their structure and peculiarities, and have drawings made of the important parts. A collection of physiology mounts should be in the possession of every school and the instructor should be on the alert for interesting specimens to be used in the class. Specimens should be preserved for future use, each class collecting material to be left in the schoolroom, thus building up a valuable biologic laboratory. Any school may build up its laboratories by this method. I have my science classes make collections, and each person leave a part of his specimens, which are added to the high school laboratories. Thus in a few years very extensive and practical collections are formed.

I would have a limited amount of dissection performed in the class. Introduce a great amount of microscopic work.

Physiology is not a mere memory science but one of observation and experiment, and above all other sciences it develops the reasoning powers. A fine opportunity is given for studying the relations of cause and effect; and we as instructors do the pupils a great injury if we confine our efforts merely to the narrow limits of a textbook and do not give the subject a broad scope and an opportunity for practical work.

Many dry textbook facts may be made interesting by simple experiments. The making of oxygen is a very attractive illustration. Show the pupil how to construct the apparatus, then allow him to arrange it for himself. Show him the materials needed; tell him the constituents of the manganese dioxid are obtained from the chlorate by heating the mixture, and that the presence of the manganese dioxid is necessary to liberate the gas. Teach the process of upward displacement. Illustrate the effect of oxygen on a glowing coal, place a piece of ignited sulfur in a receiver of pure oxygen, show the spontaneous burning phos-

phorus and burn a piece of picture wire. This will impress the idea of the great chemical affinity of the vital constituent which is found in the atmosphere indelibly on the pupil's mind. He easily imagines what the result would be if the air were composed of pure oxygen and perceives the use of nitrogen as a diluent agency.

Among other simple experiments are the following: an examination of the circulation in a frog's foot; the effect of carbon dioxid on limewater and on a flame; burning a bone, thus removing the animal matter; soaking a bone in acid, removing the mineral substance; showing the process of fermentation by putting yeast with a solution of molasses and water; explaining the action of soap; and many other practical illustrations suited to the convenience of the instructor and adapted to the facilities of the laboratory.

A sufficient amount of hygiene should be considered in the high school, but this phase of the subject should be taught less for its discipline and more for its information.

I for one feel that the Regents should be encouraged in their efforts to establish laboratory courses in our high schools. I, personally, think a laboratory course in physiology would be a great benefit to our work in the sciences. Why not urge the Board of Regents to institute an experimental course in physiology, one similar to the courses already established in zoology, botany, physics and chemistry?

We need to reach down into the first year high school work. This method of teaching the subject would give the pupil an acute sense of discrimination and would aid him "to think." In conclusion, I urge the members of this section to discuss freely the subject which has been introduced.

Miss Katherine S. Wetmore—My somewhat limited experience leads me to favor the removal of physiology from high schools entirely. From five to seven years of physiology have generally been completed by the pupil on his entrance to the high school. More advanced study presents technical difficulties which are beyond his power. Even in some of our colleges pure experimental physiology has been found so difficult that hygiene has been made a substitute.

After so many years of physiology study in the grades, the pupils become tired of the subject. The result is often a lack of interest fatal to any subject. I have known high school classes to be seriously harmed by good courses of physiology for this reason.

A good laboratory course in zoology or botany would give the necessary training for a later course in experimental physiology, if the pupil should desire one. A practical course in hygiene would be a good substitute for physiology, taking up such subjects as the care of the body, of the room and the clothing.

Prin. J. S. Kingsley—I am convinced, from my experience, that the ground covered by our physiology courses today in our state high schools could be traversed in the grades, particularly in the seventh and eighth. This would make the high school curriculum less crowded.

I am in favor of a considerable amount of experimental work to accompany physiology teaching. Such subjects as the capacity of lungs, muscular growth, the simpler facts as to the action of the digestive fluids are not too difficult for experiment and demonstration.

In our school we have a great deal of success in simple dissecting and microscopic work. The pupils prepare their own slides, not of course the material for them. Two kinds of representations are made of the subjects studied, first, pen drawings, second, colored sketches. The former help to teach the form and outline, the latter mass and color. Of course, if but one of the two can be used, the outline drawing is the more important. We also derive much benefit from the stereopticon.

Hygiene should not crowd out physiology in the grades, since a pretty definite knowledge of the structure and growth of organs is necessary as a basis for hygiene. If physiology is not emphasized before the high school, the large percentage of school children who do not reach the high school will miss it altogether.

Some idea of common diseases and simple methods of treatment should be given in the grades. The germ theory, for

instance, though too difficult to be taken up in detail, is too important not to be treated in a simple way. This is one of the subjects, by the way, which can be illustrated by the slides furnished by the state department.

Inspector Charles N. Cobb—It seems to me that experimental work along the lines just suggested has been to a large extent neglected in the high schools of the State. In my own visitation of the work of the schools, I find that there is less experimental work done in physiology than in almost any of the other sciences. The reasons perhaps are these: First, the subject of physiology has been taught in the schools more years than the other sciences, and therefore that subject has traditions and methods of teaching clustered around it. We all understand that the methods of teaching any of the sciences, years ago, were of a kind that required very little experimenting.

Second, I think the greater part of the teachers of physiology in the State find it more or less difficult to provide experiments, more so than in the other sciences.

Third, I find that the subject of physiology is not always taught in the schools by the science teachers. There is a sort of opinion prevailing that any of the licensed teachers in the State can teach physiology, and that opinion is rendered more convincing because physiology is one of the subjects in which they have to take examinations before they receive a license to teach. Where the work of the science teacher is so great that some assistance must be provided, it is quite likely to be provided along the line of physiology.

What can be done to remedy the condition of affairs, is a question. I am glad to say that some of the schools in the State are providing most excellent teachers of physiology. Some of them are experimenting and having their students perform experiments before their classes.

My judgment is that this association could render material help to the cause of education, not only in this State but elsewhere, by having a committee appointed to devise the most desirable course of experiments for high school physiology, and not only to devise the experiments but either to give or refer to explicit directions as to how they should be performed.

I know there is a feeling on the part of some people, who never did such work, that instructions harass them in their so called freedom in teaching the subject. But, if they are told how they can do the experiments, they can make any variations which they find preferable, and I think there will be no trouble.

Prof. A. D. Morrill—It seems to me we might do well to determine more definitely just what is the object of our discussion. Some of the older textbooks bear the title, *Anatomy, Physiology and Hygiene*. Which of these are we discussing and at what stage? I notice that some are making physiology the important subject and some hygiene.

As for experimental work in the grades, it would seem that anything but simple experiments in hygiene, to teach the child to care for his health, are out of the question. If we are discussing pure physiology, it does not appear to be a subject suitable for high school pupils. It has been my experience that seniors in college, with all of their previous training in chemistry and physics, are not too well prepared for it.

As I understand the question, it is high school work which is now before us. Though I do not consider experimental work entirely out of place, I think that observational work has the greatest value. I have a friend who has been teaching physiology in the high schools of Pittsburg with pupils of 13 or 14 years. He requires every pupil to perform a great many experiments and is much delighted with the result. They are largely observational. Many experiments are performed by the instructor and others by the aid of the pupils.

I should say, in this connection, that some simple manual of experiments would be desirable in the hands of all the physiology teachers of the State.

Miss Gertrude Burlingham—We have been doing experimental work in physiology at Binghamton for two years. This year we are doing better work in laboratory, I think, than we have done heretofore. The work of the pupils in the grade taking physiology has been so arranged that the hour preceding recitation is free, so that, when we go the laboratory, we have two periods for work. As a rule, we go only once in two weeks. The first time, I generally take the class to the chemical labora-

tory, and they find the composition of bone, each one weighing a piece of bone and performing the entire experiment for himself.

Then we do more or less microscopic work. Two students work at each microscope, and 16 work in one division. We study blood cells, epithelium muscle, bone, yeast etc.

They have performed several experiments on foods, testing for sugar and starch and demonstrating the action of the digestive fluids. In addition, there are certain experiments which I perform before the classes. I have found, I think, an interesting way to introduce dissection. There are some animals which the pupils do not object to seeing dissected. Last term, I showed the class a rat, having prepared it before class. They were delighted with it, and no one objected to examining it. Even other classes came in our room to see it and were eager to examine it.

The kind of work outlined above, I find, gives them a desire for other experimental sciences. At our last laboratory exercise, one girl asked about zoology and said she wished to study it if she could. No ill effects from this sort of laboratory work have come to my attention.

Prof. J. E. Kirkwood—I have had no experience myself in the teaching of human physiology, my work having to do entirely with botany, but I would like to ask if it would not be practicable to emphasize, a little more, the physiological side of botany and zoology. It occurs to me that by so doing there would be supplied to high school students a course in general physiology leading up to the more special subject of human physiology.

There are many physiologic experiments which can be performed easily on animals and plants, specially the latter. These have regard to growth, the relations of organisms to light, temperature etc., the effect of light and darkness on the growth and structure of plants, the process of digestion as exemplified in certain starchy seeds or grain, specially maize.

In view of the fact that so many high school students never reach a college, where they might have better opportunity for experimental work, would it not make the course in human

physiology in the last year of the high school more profitable if it were preceded by a more general course, offered by bringing to the front the physiological side of botany and zoology?

Prof. F. Z. Lewis—I do not desire to criticize existing methods; yet, it seems to me, some change is needed in the physiology teaching of the grades. We high school teachers find we do not derive so much benefit from the earlier physiology teaching as we should expect from the time put on it. Grade pupils are not mature enough for physiology. Arithmetic and geography and the other fundamentals belong to an earlier period than physiology.

Horatio M. Pollock—From the discussion of the morning, it is evident that we are not a unit on the question of experimental physiology. We evidently need more light. I therefore move, as Mr Cobb suggested, that our chairman appoint a committee to prepare for the association and teachers of the State a laboratory course in physiology suitable for the high school.

The motion was carried; and a committee [*see* p. 458] was appointed by Chairman Kirkwood.

Section C. EARTH SCIENCE

LIMITATIONS OF SCHOOL MUSEUMS IN NATURE STUDY

BY PROF. R. ELSWORTH CALL, BROOKLYN INSTITUTE OF ARTS AND SCIENCES

It is assumed at the outset that nature study, in at least two of its forms, is now recognized as an essential part of the work of the elementary school. Just what part must be determined by the needs and opportunities of the various communities. The subjects pursued will, of course, differ, and it is quite proper that they should. Towns and villages along the Mohawk, the Hudson, the Genesee, will find occasion for diverse work along nature lines wanting in the region of seashore. It surely will not be argued by any intelligent instructor that all nature must necessarily pass in review in the elementary school. If such be the position of instructors, it will be only necessary to say that their interpretation of such work is both pedagogically and *scientifically* wrong.

In the first place, the position is taken that nature study is not an end in itself. It is secondary in importance to the purely disciplinary and culture studies of the ordinary curriculum. The exact information which may come to a child, in point of real utility, may be regarded as nothing compared to that far more important end which teaches the child to see and to think. The possession of a vast array of facts that are not susceptible of relation among themselves, and which can not be made a part of the child's mental life, is worse than valueless to him and harmful in respect to his general culture. It is harmful because he does not look on nature as a unit, can not, in fact, do so; because coordination is impossible in the case of the average child, and without coordination of facts there is dissipation of intellectual energy. Possession of a large number of facts which are isolated from the child life and which belong only to maturer years is valueless in the mental life of the boy or girl; it were as well that the young mind be tried in the direction of the trigonometric functions and in the algebraic processes as to attempt to develop intelligent ideas of the great laws which underlie every line of investigation in nature work. In other words, successful nature work deals with few subjects, does not attempt, at any time, to compass the round of the natural sciences, confines itself to matters not beyond the age and intellectual ability of the child, and seeks to present a single phase as completely as possible within these limitations.

One of the serious mistakes, as we view it, of nature work lies in the attempt to make the youthful observer an original investigator; to make of him a discoverer. My observation has been that this mistake is never made by those who themselves know aught either of the real nature of elementary science, or of the processes by which the great sum of scientific knowledge has been attained. Nor is it likely to be made by those who understand the real nature of teaching. But it is often made by those who take this or that subject as "fads" are taken, because it is so "nice," and because it is "done in that way" in such and such schools. This leads me to urge a caution, based on a good many years' experience as a teacher of science in both elementary and secondary schools, and that is to make sure that

the subjects selected are all within the comprehension of the average child mind. I mean, simply, that if botany, or rather the study of plants as units (for such only it should be in the elementary schools) be pursued, it should be only along the lines of their gross structure. Histologic processes are far too refined, and the subjects themselves too greatly removed from the child's ordinary knowledge, to make their attempt profitable. But the study of seed germination, as a process dependent on light, heat and moisture, may not only be pursued intelligently but with the greatest profit when directed by the skilful teacher. I do not mean the ordinary process of planting a few grains of corn, or a few beans in a small box in the schoolroom window, to which half-hearted and not altogether intelligent attention is directed, at stated times, by a teacher, but, rather, comparative studies of germination in sand both wet and dry, in clay and other soils, with and without watering, in the sunlight, in shadow, in the dark basement, and comparison of the several boxes by the children themselves, their comparison being instigated by skilful and intelligent questioning or even suggestion by the teacher. The germination and growth of plants of common experience by such processes as these and under these diverse conditions soon mean something to a boy or girl. Later, in the field excursions which the real teacher will always take with her classes either as wholes or in parts, it will be easy to direct attention to weak or starveling plants that may be seen out of place or in the midst of an unsuitable environment, and there are always such, so as to fix the fact of the schoolroom study as a fact of out-of-door nature. It is believed that such work as this is both valuable and profitable; it is valuable because it relates to facts of common experience, and it is profitable because a habit of seeing and of interpreting is engendered which helps the child answer for himself the "why" which ever arises in his mind.

It is generally assumed as a principle of good pedagogy that no one should attempt to give instruction in subjects he does not himself know. Specially true is this in nature work. Not only should the teacher know the general subject far beyond the possible limits within which he is to give instruction, but *the particular* item for the lesson of the day or the week should

be carefully thought out and developed. I do not suggest this as a matter of theory but of practice. It would be unwise in the highest degree to allow children to bring leaves, for instance, of all kinds from divers plants and trees, should leaves happen to be the subject of the week's work. But certain leaves, or leaves from certain plants or trees, alike for all children, should be made the basis of the child's observational and descriptive work. And even this work should proceed with the greatest precision and care, for the primal concepts are the ones of greatest importance to both teacher and child. The time has happily gone by when we are forced to sit and listen to the vapid sayings of the old-time preacher, who informed us that he had not prepared a sermon in advance but had just received an inspiration and guidance, and would preach as the spirit moved him! Unfortunately, this method does not seem to have yet passed away from the schoolroom procedure, and in nature work particularly do teachers seem to expect or to await a momentary inspiration. It often never comes, and the lesson is just so much lost or wasted time.

The wisest position, it seems to us, is to require nature work as developing a side of the child mind which would be neglected. Let this work be determined by the environment of the school and by the training of its corps. Let the amount be a matter of utter indifference, but let the quality be of the best. Let the scheme pursued be determined by the conditions dominant in the outdoor world and not those seen from the schoolhouse or study window. Let the suggestions for nature study come from those who know Nature and know how to woo the coy goddess. The classroom work should not be too systematic or too complete. If so, the study becomes a mere collection of details without body or parts, only size. The information imparted should all reach the child by way of concrete illustration, and the illustration should be readily accessible. Due discrimination should be made between those subjects which may appeal to the child's notion of objects and their relations, while the abstract phase of nature work should never enter the elementary schoolroom.

In the very short time allotted to this opening discussion it must not be expected that other than a most general statement of the matters involved in nature work can be made. So far as suggestion is possible it seems to me:

First, that nature work should proceed along the simplest lines possible and concern itself with intelligent study of common phenomena. The most common and abundant plants, for example, will answer every purpose along biologic lines, and their study as a part of a system, speaking now of systematic botany, should be avoided entirely. Angiosperms and sporocarps, dicotyledons and bacteria, vascular cryptogams and metaspermae are all worse than useless as any part of a teacher's armamentary in the elementary school. But the corn cockle, the buttercup, the dandelion, the violet, the Mayflower, the spring beauty, as units that are to be studied only for the information they may afford of the gross structure of flowering plants, and as a foundation of number and language work, should be made the basis of classroom nature work.

Second, that nature work should confine itself to a few only of the plants or animals to be studied, and these should be carefully made the basis of work which may later assume definite shape in the child's mind and lead to independent observation. The idea I should wish to emphasize here is that around a few well known forms may be grouped a series of wider studies that will serve to induct the child unconsciously into the broader paths of scientific work. His work now is scientific only in the sense that it is methodic.

A third point I would emphasize is that nature work is not necessarily science. It is not classified knowledge. It is simply intelligent observation and carefully directed questioning. The systematic part comes later and naturally with maturity; and, in passing, it may be said, for the purposes of elementary instruction it matters little whether it comes at all.

My fourth postulate will be that it is quite immaterial what particular line of work commences your course, so long as that course begins with botanical matters as being facts within the ability of the child to see and about which he can reason.

Animals, perhaps, should be last and least in the whole scheme of work. It is not because children know most about them that this course is urged but because they know least. The complexity of the two great divisions, the whole differences between animals and plants, would lead one to defer instruction along those lines to the very latest. It is not a sign of utility that children are interested in animal study; the comparative value can be based only on the results, and the results with the animal forms are uniformly less obvious and trustworthy than those reached with the plants.

My last mentioned suggestion leads naturally to the sixth statement, that it is method, and not fact, which is sought in nature work. The facts all ought to be subordinated to the one thing which secures power to see and to express. It is the variety of nature that makes her so useful to the teacher in developing both these sides of our work. Here the teacher who knows nature rises above texts and schemes, above philosophies and theories, above concepts and appercepts and all the other wonderfully intricate and sometimes meaningless trade terms of modern school teaching, and brings her boys and girls right up to nature's heart, and makes them glad that she, and not books, for the time takes their attention.

Better leave nature severely alone rather than abuse her. She has no secrets which time and patience will not disclose to the teacher who knows and who wishes to know. But she has niggard hands for those who seek to force her secrets and who pervert and abuse her disclosures. Such use only can result if you do not know her first-hand. Don't attempt nature work before you are prepared. Don't expect a sudden intellectual wakening like that which came to Saul of Tarsus; you will be disappointed if you look for this in either yourself or your pupil child. Don't measure the knowledge which your boys and girls possess by questions and stated answers. Measure it rather by their ability to see and to reason in child manner; for this, and this alone, is the end at which nature work aims.

Now, to this end, the school museum should be directed. This will mean, of course, local collections, first of all. They should be full and *complete so far as they* go. A single life history of a

beetle or a butterfly will answer as well as the life history of a dozen of each. The shells found in local ponds and streams, on the hillsides and under the logs and stones of the near-by farm, will serve as well as the rare and costly specimens from Ladoga or New Zealand. It is not rarity, which may interest only the connoisseur and the expert or the original investigator, but typical forms that interest the educator. Not all birds but local birds, not all plants but local plants, not all soils but the soils of the near-by farm, interest your pupil (and not all pupils at that) and they should be in the school museum. My experience in museums, which extends over a number of years, has taught me that a multiplicity of objects is not only confusing but is positively injurious to many child minds. In a large and richly endowed museum of my acquaintance, is a beautiful and nearly complete exhibition of North and Central American birds. Among these are practically all the 400 known species of humming birds. It is a very rich and very valuable scientific collection. But in this part of America we have the single species of Trochilus, the ruby-throated humming bird. It is the humming bird of our textbooks. A child with his classmates and teacher will visit this great museum. Those of you who know the child mind can well understand that no clear conception of the common humming bird can come to a mind confused with 400, or more, different objects of a related character. Instead of a clear cut opinion or knowledge, a confused notion only is secured by the young mind. The school museum should remedy this evil—for educational evil it is—and supply only types. A hawk and an owl will suffice to illustrate the characters of birds of prey; a crow or a jay will answer as well as a hundred others; a heron or a crane will serve to show wading birds; a duck or a goose, the peculiar features of a swimming bird. I think, in short, nature study should be first-hand, supplemented by a type museum, the museum to be directed first of all to local animals, plants and rocks or minerals, and next to type forms of wide utility not represented in local forms. Clear cut, definitive aims should be at the basis of the school museum, and these should, primarily, look to local forms.

I think, if personal expression is permissible, that every school should have a room, or its halls, devoted to proper cases for exhibition of local animals and plants. The expense is small; the returns will be very great. Museum methods may be tabooed except so far as orderly arrangement is concerned. Cotton in all stages of growth and manufacture, iron ores and stages in their reduction, glass-blowing, book-making, calico-printing, varnish manufacture, the chief industries, or local industries of any nature, may enter into this museum. It then becomes an adjunct to the regular and daily work of the schoolroom.

Boys and girls become easily interested more in local shells and bugs than similar objects from Tasmania or Kamchatka. The one they see twice a lifetime; the other they meet in creek or river or pond each time they visit the country. As teacher, you know the value of knowing and naming the common things about you. Knowing them is of paramount importance; naming them a matter of little consequence. It is simply, in the museum, a question of knowing Doryphora decemlineata and knowing a potato bug; of knowing Strongylocentrotus drobachiensis and the green sea urchin! The one name reaches the child mind up to sixty or seventy years of age, the other the trained mind, which is one in 10,000!

The school museum should be methodically but simply labeled. It should tell all it could to an inquiring young mind.

Lastly, the school museum is not, or should not be, a research museum, but a place of illustration of commonplaces in natural science. The child is not an original investigator and should never be placed in the attitude of one. The world has learned a vast array of facts by hard knocks. Don't knock the child similarly. Let him "be the heir of all the ages." Let him see the finished products of nature and let him reason about them, about evolution, and development, and phylogeny, and transmutation, and variation after he has reached mature years and learned to see; after he can discriminate between a cabbage and a clam; after he can tell the difference between an oyster and an owl.

The school museum then is of necessity small, but inclusive; its ideal *is selection; its aim is* training and observation.

Prof. Amos W. Farnham—Knowing that I was to come third, supposing too that we should have a session of considerable length and coming the last day, I did not count on saying very much at this meeting. I did not know what would be the contents of the paper read, so I was considerably in the dark, not knowing what to prepare, and came without any ideas whatever, waiting for them to come after the paper had been read—or as it was being read. Therefore, I am not equipped from such inspiration.

I believed that the paper would be largely in the interest of nature study. Coming in this section, speaking of nature as a school museum, it would seem that we have a right to talk on other subjects; and, as this section is given largely to the subject of geography, my mind was more on geography than the nature study, and I have a thought which I shall give. It regards school museums and their limitations.

The school museum in by far too many schools is conspicuous because of its absence. And, when it really has an existence, in a majority of cases, its limitations rather than its resources are most noticeable. We may safely say that the schools equipped with well furnished museums are comparatively few. That the museum is not found today in most schools is due in most cases to the school authorities rather than to the teachers. The crying need is for suitable rooms for collections. Teachers, pupils, patrons, and their friends would aid in forming collections if proper provision were made for their preservation and use. Empty or partly filled shelves and cases invite specimens, and the invitations are sooner or later, usually sooner, accepted and responded to. Every teacher finds pleasure in labeling, classifying and installing the specimens that come to his hands. Every teacher knows the value of adequate illustrative material, more often from the lack of it than from its use.

The introduction of nature study has increased the need of school museums and of better equipped museums. Nature study has enlarged the collections of botanical and zoological museums, and given a mighty impulse to the collecting of

geography materials. Nature study gets its materials from every branch of natural science and natural history. Its aggressive work has benefited many other lines of study.

The purpose of the museum seems to be to furnish in a concrete form proper material to illustrate, not the teaching of natural science, natural history and nature study alone, but the teaching of literature, general history, and in fact almost every branch of school study. To accomplish its purpose, even in a modest way, the museum should be furnished with collections to illustrate the teaching of the great human industries: agriculture, grazing, lumbering, mining, hunting and fishing, manufacturing, and commerce. These collections should include specimens of raw materials, specimens of manufactured articles in their different stages of completion, maps of regions where these industries are carried on for export trade, as the wheat region of the Red River valley, the seven leading corn states, the Pennsylvania coal region, etc.; also maps of the great industrial centers, of trunk lines of travel, by land and by sea; pictorial illustrations of railway trains and ocean steamers, and of the different races in their own homes, to illustrate modes of living and climatic conditions; models of typical topographic forms; pictures and casts of works of art; and other unnumbered things that find legitimate places in the school museums. It may be remarked here that some museums so called contain not a few specimens that are of little value; queer things, abnormal growths, "any old thing," objects that refuse to be classified, rubbish. A museum is something more than a curiosity shop.

The increased interest in pedagogic studies has increased the demand for school museums, and made the teacher painfully aware of its limitations.

The museum often brings the field to the classes in geography, botany, geology, and nature study, when the classes can not go to the field. It is true that many museum specimens are bits of nature out of their settings; but, with the aid of pictures, preferably the stereopticon, and with the aid of the library, their settings may be restored.

Every teacher may at least make a valuable collection of pictures, and then properly classify them for use in his own classes. He may have access to this nucleus of a museum, which, if well used, may be an entering wedge to something larger, more general, and more useful.

Inspector Arthur G. Clement—I enjoyed the paper read very much, and do not think anything could be added. However, I would suggest that every student in a class be allowed to make collection of animal or plant life, or of minerals, and would encourage the students by promising them to preserve the best collection in the museum. I think that the possession of a few prepared specimens put up in alcohol, showing life histories of animals, such as a fish or a frog, would add interest to a school. For instance, such preparations as are put up by Kny & Co., of New York city.

A motion was carried that Prof. L. I. Holdredge, of Hudson N. Y., be elected secretary of this section for next year.

Section D. NATURE STUDY

THE RELATION OF NATURE STUDY TO PHYSIOLOGY AND HYGIENE

BY ELIZABETH CARSS, TEACHERS COLLEGE, NEW YORK

When the problem of arranging an elementary school curriculum is to be confronted, the subjects which are oftenest most difficult to place are nature study and physiology and hygiene. It is generally conceded that somewhere, somehow, these subjects must appear, though those arranging for them may have no clear conception of their real value or significance. The consequence too often is that they are introduced apparently as an afterthought. This is specially true of the subject of hygiene, which is frequently put under the head of nature study, but which, as presented, has no real connection with it.

Hygiene is too often taught after the manner of the bygone lessons on morals. As these lessons concerned themselves with some virtue, such as truthfulness or love of country, and dwelt on it by means of story and precept, so the work in hygiene usually proceeds by laying down certain undisputed and valuable

maxims concerning digestion, circulation, cleanliness and the like, and tells what should and should not be done. In both cases, whether in preaching morals or hygiene, the mark is missed because such work comes in no intimate or vital connection with the activities and the life of the child in school or out of it. Why should these lessons in hygiene in each grade be cut away not only from all other subjects of the curriculum but even from nature study, which, if properly taught, may be made the most efficient means of impressing important hygiëne principles without losing its own intrinsic value in helping the child to interpret the world about him?

Before taking up suggestions for a specific plan of nature study, in which hygiene in the broadest sense is the guiding subject, I wish, briefly to summarize the aims, scope and methods of nature study as outlined in the books which show the best thought on the subject.

During the past ten years a somewhat definite conception of what nature study is, has gradually been shaping itself. The newer thought has discarded the old object lesson, in which any object, animate or inanimate, natural or manufactured, was used as a means of training children to observe. This was the end and aim of the lesson. No matter if the observation had any connection with other subjects or not, this faculty was being trained. Even today this idea is rigidly held by some who claim that they are teaching nature study, simply because such objects are chosen from nature, as stones, twigs or leaves.

However, in all the best plans a richer thought has found its way: the idea of life in relation to its environment, involving the interaction of life processes and the relation of one form of life to other forms.

The scope of nature study is generally agreed to be a wide one, in some cases so wide that there is no fact in the universe left untouched. Indeed, in thus wandering over the realm of natural phenomena, the limits of nature study become very hazy. In some schemes geography is included with natural history, in others both geography and the study of primitive peoples; while others, excluding these larger topics, embrace the whole field of

natural science subjects, including a study of plants and animals, rocks, soils, as well as physics, chemistry, astronomy and human physiology.

The aims are as varied as the courses presented. Observation is placed by many in the fore rank of importance. It is usually stated that observation is to be followed by reasoning, but unfortunately both teachers and children are frequently happy if only some conclusion can be reached, whether based on sufficient data or not.

Another aim set forth is the attainment of an attitude of mind toward nature, namely, love for nature and interest in it. With a good teacher this aim will be of distinctly greater value than the former and will be made to include it.

A third aim emphasizes utility. "Teach such facts as shall enable the child to master and utilize physical conditions of life." To this end agricultural, industrial and economic topics have found an important place.

Again, a knowledge of classification of plants and animals through a study of types is made the chief aim.

Finally, some have gone so far as to define nature study merely as an aid to language and number work. In this case there is probably no real nature study at all, and those who make use of the term have caught a popular idea of which they have little or no understanding.

It is of interest to glance over the topics and materials proposed by various authors as a means of accomplishing these aims. In several cases it would seem that the writers of nature study manuals had endeavored to see how many interesting facts and questions could be heaped together. This results in securing information about life rather than a conception of its unity. Many of the topics chosen are full of valuable possibilities for teaching hygiene and physiology, but the hygienic importance does not seem to have been in mind and is nowhere specified in the treatment of the subject.

The following topics are those most generally accepted under the head of nature study.

1 Animal life

a Domesticated animals

Characteristics; structure and functions; relation to the primitive history of man; taming and subjugation; man's care and the reaction of carelessness on himself

The last two topics are made very prominent in Professor Hodge's book, *Nature Study and Life*. He goes a step beyond his contemporaries in suggesting that the laws of healthful growth of plants and animals must be ascertained in order to insure normal development.

b Life histories of insects, frog, toad, fish etc.

Beneficial and injurious animals

In this connection another point bearing on hygiene has been made by Professor Hodge, when he would have the children work for the general health and happiness of the community in destroying harmful creatures that impede the progress of man and in nurturing those that assist him in this progress. This involves a study of household pests and of bacteria and germs present in dirt and dust, and of the means of removing their causal conditions. This idea has been suggested by several authors, but none have given it the prominence prescribed by Professor Hodge.

c Bird study

Details of external structure; identification; habits; usefulness to man

d Miscellaneous animals of woods, ponds and streams

Hibernation of animals in winter

e Type studies and classification of animals

Some of this work is of great value, but is at times carried to the extreme suggested by Howe in his *Systematic Elementary Science*. Here the types to be studied range from the cow to the sponge, and in outlines presented, analysis of the various structures is carried so far that such empty questions as the following are asked in reference to an animal as familiar as the cow:

What is the shape of the animal? Is it warm or cold? Has it hair? Where? Hoofs? Where? Horns? Where? Where placed? How many?, and so on for head, ears, eyes, eyelids, eyeballs, nostrils, mouth, lips.

The attitude of intelligent children toward such work might well be that of disgust. Why concern ourselves with endless details when so many more important questions demand early and thoughtful consideration?

2 Plant life

a Germination and growth

Parts of the seed; study of stages of growth; storage of food in seed

This is a favorite topic, because materials are easily obtained, and the teacher can find typical lessons as guides. The best possibilities of the subject are, however, rarely realized and the same work is often repeated throughout the grades of the school till the children have wearied of it.

b Fruits

Descriptions and collections of different kinds; dissemination of seed and fruits; storage of food in fruit

c Trees

Identification and appearance: parts; uses; growth of twigs and buds; flowers; fruit; shedding of leaves; movement of sap

d Miscellaneous plants

Fall and spring flowers; common weeds; common vegetables; plants beneficial and harmful; bulbs; fleshy stems; fleshy roots

Teachers frequently teach functions of parts of plants, but usually in a way that adds little life to the subject and often conveys erroneous impressions. Among the commonest fallacies taught and found in popular nature study books are the following: Plants breathe in carbon dioxid and breathe out oxygen; lenticels on stems are like the pores on our own skin; bud scales are for the purpose of keeping the little leaves warm. These fallacies become firmly fixed in the children's minds, and by the time they have reached the high school a long and patient struggle is necessary to convince them of the error of such statements.

3 Minerals, rocks and soils

Some systems of nature study outline extensive work for the study of minerals and rocks. In several instances long lists of minerals are classified, the names and kinds of crystallization being learned in each case. This seems to me a waste of children's valuable school hours, of which there are all too few.

However, some work on the common rocks and soils may be made of great value and may be connected with some of the important facts of hygiene, as I shall attempt to show later.

4 Physical science and astronomy

The plans in these subjects proposed by some authors seem to assume that children will be able to talk freely and intimately of gravitation, the solar system, molecules and molecular forces, subjects which, in my opinion, have no place in the elementary science of the grammar school, though a knowledge of some of the laws of physical science in their more apparent and simplest manifestations is absolutely *essential.*

5 Geography

When geography is included under nature study, the outlines are very meagerly presented and could in no way satisfy the full requirements of so important a subject. Weather observations are almost invariably prominent in courses of nature study and require daily record of climatic conditions, but go no farther than this in the lower grades.

6 Primitive life

The study of primitive life introduced into the plans of nature study usually concerns itself with statements of tools, weapons, utensils, travel, transportation, shelter, language, food and clothing. Sometimes the children's activity is called into play by constructing some of the objects employed in the early period of man's history; but, unless the whole subject is presented in a skilful way, even this constructive work may not prevent it from resulting in a mere amassing of facts.

Time will not permit me to present here even the outlines of a complete course in nature study based on hygienic-social principles, but the following topics will sufficiently indicate the character of the work. I have not tried to search for entirely new subjects, but have taken the old and attempted to weave a newer thought into them in order to bring them into more vital connection with the real life of the child.

In the study of hygiene we have not in mind the individual alone, but the community and race as well. We can not secure social, physical or moral betterment of the race till the individual has learned his responsibility, and the necessity of sacrifice in order to secure the higher development of the race.

In the first two topics presented, this has been my leading thought, and with it, the necessity and gradual development of cooperation among individuals.

The race can be continued and elevated only by the continuance of home and family life, which becomes the center of effort. Animals and man make home the focus of their best and supreme endeavors; therefore I wish to bring this thought of home life to the children as early as possible and let the thought grow with them. Since home is the center of our life, we wish to make it suitable to our needs, comfortable, beautiful, clean and happy. We also want this home in pleasant and clean surroundings.

Home and family life

This subject is introduced by animal study. Animals are selected which most clearly exemplify family life in care of young, provision for shelter and food and the companionable relation of parents.

In actually presenting the work to children, I should definitely select certain birds or other animals for careful study. The following topical questions and headings are given in a way that may render them generally applicable. It is important to bear in mind that in discussing suitability of home, food and various modes of life, general appearance, external structure and characteristic use of parts of the body are not overlooked and would be here incorporated were there time and space.

1 Home life among animals

a Structure and characteristics of home or shelter

In the case of each animal studied the kind of home, materials used in constructing it, the cooperation of parents in making it, how suited to the needs of the animal, where situated, how protected from enemies, from exposure to storms, what attempts at comfort, what attempts at cleanliness.

b Rearing of young and relation of mother to the young

What sacrifice is made by the mother in the care of her young? Assistance given by the male parent. (In some cases the female has everything to do, but most birds illustrate the mutual care of male and female.)

The reason for all this labor and sacrifice is the perpetuation of the race, and the home becomes the center of this perpetuation. The bird or wild animal has many little ones to bring up at a time. In each case how does she manage to keep all in health and clean? How does she teach them to care for themselves? If any of the number is sickly, is the mother able to help it? How?

c Future of the home

In the case of each animal studied, what becomes of the home, children, mother and father after the young can care for themselves? The old home is usually deserted and new

ones built each year. Parents and offspring become separated and are soon strangers to one another.

d Comparison with our home relationships

Among ourselves love and interest continue throughout life and are passed on to grandchildren. There is a longer period of care for the human child and greater sacrifice made for it by the parents. The value of continued affection: parents can better help children by ripened experience, children can bring fresh ideas to parents and care for them in old age.

2 Home life of man

a Hunting and fishing stage of existence: uncivilized man

The Indian and Eskimo may be studied in this connection.

(1) Character and structure of the shelter or home

The materials of which it is made. The tools used in making it. The effect of climatic conditions on the general structure. The choice of materials determined by natural resources.

(2) Parents and children in relation to the home

How does the uncivilized man care for his children? What is the mother's work in the household? Do the children help when they are old enough to care for themselves? How are the babies cared for? Does the savage mother keep her baby as clean as some of the wild animals?

It would be injurious to us to be as dirty as the savages. It harms them also. They are subject to many diseases which originate from unclean conditions, and many of their children die.

They do not, however, suffer as much as we would under similar conditions, because they are in the open air and have more exercise. How do air and sunshine help to keep us healthy? How does exercise help?

(3) Food and clothing

The kinds of food. The way food is obtained and the tools used in procuring it. The preparation of the food, how prepared, by whom. Does the family gather around a table to eat the food? The kind of clothing: the way it

is obtained and prepared, and its suitability to the needs of the people.

(4) Heating, lighting and ventilation of the home.

The crude methods of heating and lighting, and no thought of ventilation.

b Pastoral stage of existence: shepherds

The subject may be introduced with a brief account of how certain wild animals were caught and finally domesticated by man, and of how this secured a constant supply of food and clothing, thus rendering life less uncertain and homes more comfortable.

(1) Character of homes

Sometimes the home and family are moved from one good pasture to another. The abode is then a tent which can easily be put up or taken down. However, where land is somewhat limited, and is owned by different people, this moving about would cause quarrels, therefore it becomes necessary for each shepherd to have his own areas of pasture and a permanent home.

(2) Family relations

Work of different members of the shepherd's family: father, mother, children. The shepherd's valuable assistant: the shepherd dog.

c Agricultural stage: farm life

Farm life as known to the children, is taken as the type rather than primitive agricultural conditions, because the former may be made more real.

(1) Character of home

The materials used in constructing it; how the materials are obtained and prepared; who puts the house together.

(2) Water supply

Where obtained: well, cistern, spring. Location of the water supply; necessity of pure water; how water may be contaminated; proper disposal of waste, where and how.

(3) Surroundings of the home

The immediate surroundings of the house; how these may be made beautiful. Where the vegetable garden should be

for family use; what the best vegetables are and how they should be cared for.

(4) Barnyard

Where the barnyard is; where it should be in reference to the house. The water supply in the barnyard. Emphasis should be given to the necessity of pure water for animals as well as for man.

Drainage of the barnyard; care of stables and stalls; care of refuse from stables.

(5) Animals kept on the farm

Careful study of the common domesticated animals; characteristics; structure; use of parts of the body; proper conditions for normal growth and development; care and sympathy they should receive from man; the valuable return made by them to man.

(6) Food

Kinds of food. Study of some of the grain plants, common vegetables, fruit trees, etc. Care of milk. Preparation of food for family use; preparation for market. Exchange of farm products, specially foods, for manufactured articles and food materials not obtainable on the farm.

(7) Occupations

Work of father and men: care and tillage of the fields; planting crops; haying; gathering in crops; threshing, primitive and modern ways; carrying of products to market, to the mill, to the dairy; care of farm animals; milking; care of roads, fences and tools.

Work of the mother: preparing food for the family; making butter; keeping the house clean; keeping the clothes in order; preserving food for winter; caring for the chickens and sometimes for little lambs.

Both father and mother educate the children in all farm occupations.

Work of the children: help father and mother to make home more comfortable and do many things to make the work easier.

(8) Pleasures and recreations of country life

What kinds? Why necessary?

Decoration and beautifying the home to give rest and enjoyment in it.

d Commercial stage: city life

(1) Character and structure of homes.

Kinds of homes. Why so many together? Necessity of greater care about cleanliness, disposal of waste, etc., because more than one life is concerned. City ordinances in regard to cleanliness of the community.

(2) Water supply

Where obtained and how brought to the houses, in what condition. Dangers of impure water. How city water may be contaminated; how contamination may be prevented.

(3) Food supply

Where obtained and how brought to the home. Danger of overripe fruits and impure foods.

Preparation of food in the home: cooking. Dependence on country for food.

(4) Clothing

Where and how obtained. How changed from raw material. The best kind of clothing for winter, for summer. How clothing should be made and worn, how cleaned and aired.

(5) Care of the home

The dust danger. Proper methods of dusting, sweeping and cleaning.

Care of kitchen sinks and wash basins. Danger of imperfect plumbing.

Best methods of heating and lighting the home.

Ventilation of various rooms of the house, specially bedrooms, sitting room and kitchen.

Decorating and beautifying the home. The value of simplicity and suitability.

(6) Recreation and amusement

The best kind for city life and why. The value of going, at times, into the country.

This long topic of home life has been chosen from a large number of nature study subjects prepared by the writer to illustrate the possibility of having the teaching of hygiene grow out of nature study teaching and become incorporated with it, and closely related social and industrial topics.

Wednesday, 11.15 a. m.

GENERAL SESSION

THE LABORATORY NOTEBOOK AND CERTIFICATION FOR COLLEGE ENTRANCE

BY PROF. E. R. WHITNEY, BINGHAMTON HIGH SCHOOL

An educational wag recently said that "after 20 years of advancement, we are going nowhere with very little progress." Notwithstanding, it is evident that since this organization was founded, science teaching in the State of New York has made rapid strides forward, as the erection of new laboratories, the rebuilding of old ones and the better equipment abundantly testify. The report of the committee of nine, giving as it did a syllabus of subject-matter and lists of experiments for laboratory work, marked an epoch in science teaching. The report readily found its way into the Regents syllabus. This association brought the college professors, normal and high school teachers nearer together and has opened up a way for a more thorough unification of science teaching in the State. Great as has been the work of the association, there are some important problems yet to be solved, and one of them pertains to the laboratory notebook.

In my opinion the weakness of science teaching lies just now along this line and also that of certification. In a large measure the making of the laboratory notebook is not only the most important work of the student, but it is an index of the kind of work done in the class and lecture room as well as in the laboratory. In some degree it tests the school and its ideals.

I have always maintained that effective teaching of science in secondary schools needs at least six things: (1) a teacher; (2) a classroom, fitted with lecture table appliances for use of the teacher in giving lectures, expositions or experimental demonstrations; (3) an *elementary* textbook on the subject—a book

that is not a fragmentary treatise but a continuous outline, clear, exact, logical, mainly inductive (a student provided with such a book will scarcely need to take notes of the demonstrations and can give his undivided attention to the explanations given); (4) a well equipped laboratory for individual work for use of students; (5) a laboratory manual or guide, separate from the descriptive text and comprising a course of carefully selected and arranged experiments to be performed by the students under the immediate direction of the instructor; (6) a laboratory notebook.

The ideal notebook will not be made till the ideal laboratory manual is produced. Many as are the advantages of each teacher making his own laboratory manual or guide to meet local conditions, which conditions are usually limitations of equipment, there are good and sufficient reasons why this should not be done. The average teacher has not the time to devote to authorship and much less time for typesetting, mimeographing, and the art of book-making. We have come to abominate much of the homemade apparatus, because it yields inaccurate results. But what shall be said of the homemade laboratory manual?

Laboratory work needs to be more exacting than it is at present. We are overdoing in our effort to do it all. The news of a class in chemistry or physics doing 80 or 90 experiments in 20 weeks naturally excites the comment "yes, a large quantity, but how about the quality?" Twenty-five experiments in chemistry and 30 in physics are large numbers to be covered thoroughly in a half year, specially if much quantitative work is done. I do not approve of turning the pupils loose in the laboratory. Personal supervision is necessary for the formation of correct habits.

The student should be provided with a loose-leaved, well made notebook, one prepared for laboratory work, containing drawing, cross section or other paper required for the work. The notes should be made in ink while the experiment is progressing, and nothing but the original, first record of the work should be accepted by the instructor. Ink wells are as necessary for the laboratory desks as for the study room desks. The notebooks may be placed in cases in the laboratory where they are accessible at all times for the teacher's inspection, and they *should not* be removed from the laboratory except for review

and inspection. Independent truthful work is what we desire above everything else, and anything that would tempt the student to cheat should be removed. The laboratory should sharpen brains to keener intellectual edges and not wits for cunning and deception. If the drawings of the object studied in botany and in zoology are well made, there is little need of written description, which, in this case will repeat the ideas set forth in the drawing. The exasperating, mechanically made notebook difficulty is overcome by incisive questions written in the space, at the end of the experiment record, left for remarks, corrections and additions. These red ink footnotes will brighten the book with color, if with nothing else. Below or after the red ink or rubber stamp corrections, which are made by the teacher at least once a week, the pupil should amplify the subject without rewriting.

The teacher's inspection and critical examination of the notebook should discover whether the pupil has followed the directions given in the manual, or has an allowable substitute; whether he has grasped the real object of the experiment; whether he has been on the alert to notice every occurring phenomenon and has realized its significance; whether or not he has fallen into bad habits of manipulation (though this is better detected and corrected while the student is doing the experiment); whether he has scrutinized carefully the results and data, with a view to discovering their significance and just what general conclusion they show; and whether the pupil has compared the result obtained in the experiment just done with previous experiments and experiences under like conditions, so that, by a thorough apperceptive process, the truths of the experiments may be welded fast in the pupils inner consciousness.

The notebook should, therefore, test six ends sought in laboratory work, namely: (1) skill in manipulation—a kind of manual training; (2) power of quick and searching observation, applied constantly till it becomes a useful habit; (3) facility in giving descriptions that are at once lucid and exact; (4) the habit of assembling material and grouping it for comparison and differentiation; (5) the ability to generalize and infer; (6) the *power of self-initiative*. This last is most important. Too

many of our secondary school students are dependent. They follow and can not lead. The reader of a notebook can not discover whether the student who wrote the book is a leader or a floater, unless he happen to know the student thoroughly. The notebook is a poor test of manipulative skill and also of keen observation.

There are many things that a laboratory notebook can tell regarding its author. It shows his penmanship, his English, his arithmetic, his general education. As "cleanliness is next to godliness," it shows that, or the absence of it. It may speak of his truthfulness or dishonesty. It is a constant examination into his progress. It proclaims his industry or his indolence. It may give hints of his desire to advance. It shows at once whether the student is in the habit of watching the clock, whether he gives his attention to details and has the ability to execute orders. But the notebook, in order to tell all of these things accurately, must be taken in conjunction with personal acquaintance with the student.

The distant college examiner usually knows little of the actual conditions in the secondary school from which the pupil comes. He can not easily determine from the notebook whether the laboratory has furnished unusual events for making wholesome and lasting impressions or has been a substitute for hard study or for strong and vigorous instruction in the classroom. It is true, however, that a wretchedly done experiment will be poorly recorded in the notebook, and that the record thus made forecasts a poor housekeeper, a slack business man, an indifferent artisan, or a careless and therefore dangerous professional person. Loose habits do not always manifest themselves in poorly kept notebooks, however.

Recently 409 leading men were interviewed by the New York Teachers Association in regard to efficiency of the schools. The answers of these practical men are interesting. While it is gratifying to learn that high school graduates are preferred to grammar school graduates, it is sad to hear the complaint that the boys, specially, waste time and material. These two items touch our laboratory work rather hard and are worthy of our serious

consideration. The notebook is almost powerless to test these points.

As about four sevenths of the time that the pupil is under the immediate care of the teacher is devoted to laboratory practice, the personal influence of the teacher is large, and it is doubtful if the laboratory notebook can properly reflect this influence, for influence surpasses instruction and outlasts it.

At present, there seems to be no recognized standard that is followed generally by the colleges and other institutions in the acceptance of science for entrance or for other standing. Each institution apparently has its own plan. I have inquired rather widely among secondary school teachers and I find that they are often surprised at the acceptance or rejection of certain notebooks by the colleges. In many cases there was no examination of the student as to fitness and the only test was that of the notebook. May heaven help the poor student who, though he may be a genius, presents an untidy notebook! But lucky, yes, thrice lucky the dullard whose chirography and drawings are perfect! The examiners must not forget that the conditions of science teaching are changing yearly. A pupil who passed a science subject two years ago, but who, from pecuniary reasons, can not enter college till next fall, should not be held strictly to the 1903 ideals. There is a good saying that "the letter killeth, but the spirit giveth life." Newly adopted regulations should not work hardships on undeserving students. Technicalities tactfully tempered with tenderness always make for justice.

I have found the examinations of the college entrance board of the Middle States and Maryland to be the fairest and best my students ever took. The questions are on a high plane. The system is commendable, and I hope the time will speedily come when all of the colleges will accept no students except those that have passed the board examinations. In the bonds of the association, the whim, foible, or whatever you may call it, of the individual college yields to breadth and nobility of purpose. The standard set up by the board is "impersonal, impartial and in every respect uniform." The demands of the board are as exacting as those of most colleges and are far more reasonable than some. In botany, chemistry, physics, and physical geography the re-

quirements are based on the reports of the committees on those subjects of the science department of the National Educational Association. The requirement on botany is modified by a committee of the Society of Plant Morphology and Physiology. In physics, individual laboratory work, comprising at least 35 exercises selected from a list of 60 or more, is required. In chemistry, the minimum number is 40. In physical geography, while it is acknowledged that "no adequate laboratory manual is at present available," individual laboratory work, comprising 40 exercises selected from an admirable list furnished, is required, with the further requirement that from one third to one half of the candidate's classwork be devoted to laboratory exercises. The laboratory notebook in botany counts one third toward admission.

For each subject there are three examiners, but it is a noteworthy fact that last year not a single laboratory notebook was read a second time.

Admirable as is the plan of the college entrance board it may be improved in one important particular. At present the notebook *seems* to be accepted, or rejected, largely on the value of the certificate attached to it, which states that the student has performed so many experiments. In the accrediting system so much depends on what is behind the certificate. Is the work genuine? Has the school acquired the approval of the colleges generally? Has the school the proper facilities of laboratory, program, curriculum and teaching force to do work worthy of acceptance? What are the influences at that school — influences that can not be registered in notebooks? Has the teacher the true scientific spirit, and can he and does he kindle his students to a glow with it? Is the laboratory a place alive with investigation and discovery of things new to the students?

How, tell me, can these things be found out except by actual inspection of the school? A personal visit will do more than tons of notebooks to get a clear idea of just what is actually being done. Closer correlation between school and college is always desirable. The helpful suggestions given by competent specialists and heads of departments will be gladly received by the school people. The plan may appear expensive, but is it not *worth while*? The colleges need better products from the schools.

The schools need more help to make the product better. I can do better teaching after a visit to the lower grades. May we not infer that the college men may learn something from visits to the secondary schools? Education is a continuous process from the kindergarten up through grammar school, high school, college and professional school.

Let me suggest that, in distributing the credits for admission, personal inspection count at least 50%, the examination 25% and the notebook 25%. As the inspector's responsibility is great, let him be a specialist in the field he examines, or a competent instructor in a cognate subject. Science certification for college entrance, if based on inspection and subsequent accreditation, will mean more than it does at present and will be more fruitful of genuine good to both institutions concerned.

Prof. O. C. Kenyon—It seems to me that, if notebooks are to be accepted by the colleges as evidence of knowledge acquired and of ability to do certain things in science, a number of rules must be made by the board of examiners and rigidly enforced by teachers concerning the proper conduct of the laboratory work and the methods of writing and keeping the notebooks.

In the first place, pupils should work singly and not in pairs or groups, thus putting the laboratory work on the same basis of independence as the regular recitations and examinations. In no other way can a teacher be sure that the notes are the pupil's own. No matter how willing students may be to rely each on himself, if they are allowed to communicate while experimenting, the quick and self-assertive pupil will do the work of others. Therefore, if the notebooks are to be of much value in the way named in the subject under discussion, there should be no communication among pupils during laboratory work. But, in order to enforce this rule and prevent copying altogether, the classes must be small, not more than 16 in a division, and pupils must be seated at some distance from one another. If the colleges will declare in favor of this rule, they will greatly benefit some of the secondary schools, where the divisions are now so large that adequate supervision is simply impossible.

In the next place, the notes should be recorded in ink, and no erasing be allowed. Mistakes can be neatly crossed out with the

ink and rewritten. This method not only enables the teacher to follow the pupil in his thinking, but it saves the pupil's time, and in most cases the paper has a better appearance when the corrections are made thus than when erasures are made.

As to corrections by the teacher, these should be made with colored ink and all mistakes corrected by the pupil. This method enables the examiner for colleges to see just what help the pupil obtained in this way. Next, there should be a supplementary report, written by the pupil from memory a day or more after the experiment is completed. This will show whether the problem or experiment was really understood. During the progress of the experiment, there will doubtless be points not clear to the pupil, and the teacher will be obliged to give help. This supplementary report, corrected in colored ink, takes the place of an examination on the experiment and is the real test of the knowledge of the pupil. After this report is finished, a list of questions on the most important points connected with the experiment, should be given the experimenter, to be answered in case these answers have not already been included in the report.

Of course the original papers written by the pupil must in every case be kept, even when copies are made.

If all these methods are faithfully observed, and if, besides, the teacher certifies to the pupil's fitness to enter college, I do not see why the notebook can not be accepted as evidence of a pupil's fitness to enter college, provided, of course, that the teacher is properly qualified.

Wednesday afternoon

GENERAL SESSION

STIMULANTS AND NARCOTICS

REPORT OF PROGRESS OF THE COMMITTEE

PRESENTED BY PROF. IRVING P. BISHOP

Through the past year the work of the committee has been directed principally toward ascertaining the effects of alcohol and tobacco on the organs of the animal body. The method pursued has been to consult, where possible, the original sources of information, preferably the work of experimenters. As much of the literature on the subject is scattered through periodicals, the

task of collecting and collating has been slow and tedious. In spite of that, a large amount of interesting and valuable matter has accumulated in our hands.

When we made our preliminary report, a year ago, we had assurance from the committee of 50 that the report of their subcommittee on the physiological and pathological aspect of the drink problem would soon be published. As this subcommittee, in addition to the original investigations which it has conducted, had access to sources of information inaccessible to us, it seemed best to delay our final report till that report was available. Owing to unforeseen circumstances, the volume has not yet been published. Early in December, at my urgent request, the subcommittee very courteously placed at our disposal proof sheets of several papers which will form part of the report. We found, however, that too little time remained for the single copy to make the rounds of our committee before this meeting; and we therefore reluctantly but unanimously decided again to defer our report. I believe, however, that the material will all be assembled within the next three months.

In addition to the work detailed above, your committee has decided to include in its report one or more courses of study in hygiene with reference to stimulants and narcotics for the grades in which such study is desirable. For this purpose, eminent specialists in pedagogy have been consulted, and one course at least is now nearly ready. We expect, also, by the next meeting, to have learned much of the practical workings of the Connecticut law on the teaching of stimulants and narcotics.

LABORATORY DEVICES

BY PROF. O. C. KENYON, SYRACUSE HIGH SCHOOL

I should like to spend the time allotted to me this afternoon in asking questions, and listening to replies concerning a few problems that have arisen in our school with reference to the details of laboratory work. But perhaps that would be somewhat selfish; and, before beginning the list of questions which I have made here, I will first mention a few apparent improvements that have suggested themselves in our laboratory work.

Laboratory practice seems to consist in doing a multitude of little things. Michelangelo, I think it was, said, "Trifles make perfection, but perfection is no trifle." If we strive to improve in every one of the details to which we have to attend in scientific laboratories we may hope, I suppose, to make some progress.

In the first place, then, I have here a first attempt at a model of a rainbow. Pupils have difficulty in understanding why the bow is round, and why the order of the colors is as it is. I have found that this model is quite a help. It consists of four concentric rings fastened to a board, each ring representing the position of one of the outer colors of either the primary or secondary bow. The post from the center of the board represents the axis of the bow, and the nail, at the end of it, the eye of the observer. The drops are represented by rings of brass wire, and the rays by wire of annealed copper. This model was made by a pupil, and might be much improved by soldering the copper wires to the brass, instead of twisting them around, as in this piece, and also might be improved in other ways.

Next the experiment on the parallelogram of forces. Formerly our pupils did this by the use of three spring balances on the blackboard in the way suggested in most textbooks, first taking the zero readings, then increasing the forces and forming the parallelogram from the increase of the three forces. This method gives fairly good results, better, I think, than the square board on marbles, but there is the objection to it, that not many sets of apparatus can be provided at the same time. So I devised this clamp and taper pin, for using on the table. With three of these, and three spring balances placed on a drawing board, and by using the increase of force, keeping the point of application at the same place, excellent results can be obtained; and the apparatus can easily be made by pupils.

Here is a piece of apparatus which we are finding quite helpful. If one attempts to prove the law of inverse squares by use of an ordinary light, such as a candle, he either finds his shadows indistinct, or else, so dim that the result is very inaccurate. After trying a number of methods, I found that pupils can easily manipulate a hand arc lamp, proper precautions, of course, being

taken against accident. The lamp should be fastened inside a box or hood, having a cover, as here, and a number of openings left in different directions. Four persons may make measurements with this piece at once. They first measure from the center of the carbon tips to the outside of the hood openings. Then, starting the arc, adjust the squares in the usual way; and then all measure from the outside of the opening to each cardboard.

This hood was made out of an old piece of ventilating pipe, the cover is a discarded electrophorus plate, the covers for the openings are coffee can covers, and the lamp is pupil-made. The cost was practically nothing; and yet I count it one of the most effective pieces in our laboratory.

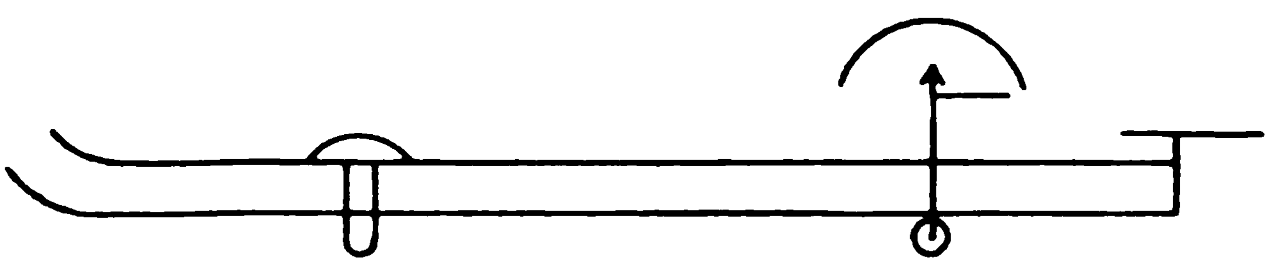
From a dentist, I learned of a very simple method of warming water. Its merit is that it takes no time, and it consists in placing an incandescent lamp, attached to a flexible cord, directly in the dish of water to be heated. To turn the switch and insert the bulb is the work of only a moment. Lately I have used the same method for keeping static electricity apparatus warm, such as the silk, flannel, electroscope etc. The lamp is put in the bottom of a pail and covered with gauze.

Another method of accomplishing the same result, is to place the materials on a wire resistance frame, similar to this, which is placed on the table and through which a current is passing. In the later method care must be taken to avoid short circuiting.

Some of you, I presume, are using these clamps for forming electric cells of various materials, as well as voltameters and storage cells. I have thought of a device for making it easy to join two of these cells, either in series or parallel. This plate extends across the block from one cell to the other and joins the two elements in these two cells, while the other plate is sawed through in the middle. To connect the two cells in series, the zinc is placed here and the carbon here, the leading out wires coming from these two screws. In order to change to parallel connection, these two elements change places and a taper plug, or wires, joins these two plates, the leading out wires coming from two screws.

Mr Williams, of the Chicago Laboratory and Scale Supply Co., told me the other day of a device in the experiment on the

coefficient of expansion of a solid, which seems worth knowing. Instead of using a rod inside a tube, as heretofore, the expansion of the tube itself is measured, cold water being first passed through the tube, then hot water or steam. The loss by radiation is not sufficient to affect appreciably the result. The amount of the elongation may be very simply measured by using a small roller placed under and crosswise of the tube. To one end of this rod is attached a long pointer which moves over a graduated arc and magnifies the increase of length of the tube. The



whole arrangement is one easily prepared in a shop, and is said to be better than the elaborate apparatus with the micrometer screw, electric attachment etc.

I have had in mind for several years a plan, which, it seems to me, would be of great profit to those entering into it. It is for six, eight or 10 persons who are doing about the same kind of work, to form themselves into a correspondence circle, the object being mutual help to one another. The correspondents would be arranged in regular order. Each person of the circle might write out a question on a sheet of paper, adding any comment or little discovery that he had made concerning it, and mail this to the next one of the circle; this paper to be mailed again within a week to the next one of the circle, after other comments have been added to the sheet; at the same time another paper is started by each person. Each letter would go around the circle before it returned to the one who started it. This person, then, if he wishes, or thinks it worth the while, may write up the article for a paper or for presentation at a science meeting. Of course this is rather a slow method; but for us who are not near the larger cities and who can not often meet in clubs, the plan seems to me to be worth trying.

If I may have a few minutes more, I would like to ask these questions.

1 Is the tangent galvanometer out of date? I am told that it is in disuse, specially in the western schools.

2 What success do pupils have in using the proof plane and galvanoscope?

3 How much time is given to the proper number of figures to be kept in making computations?

4 How much attention is being given to the proper sensitiveness of the instrument for a given purpose; for example, as to when a platform balance may be used and when the sensitive balance is much better?

5 Is a spring balance accurate enough for experiments with the simple machines, as the inclined plane and pulleys?

6 Should friction, wasted work and efficiency be found in experiments with machines?

7 Is the Ames & Bliss apparatus for accelerated motion preferable to the ordinary Atwood's machine or to the inclined plane?

8 What is the best quantitative experiment for pupils on the transmission of pressure in liquids and gases — Pascal's law?

9 Is it worth while to teach the Réaumur scale of temperature?

10 How does the cylindric mirror compare with the spheric for pupils' use?

MEMBERS 1902

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University of the State of New York

High School Department

INCLUDING ACADEMIES AND ALL INSTITUTIONS OF SECONDARY EDUCATION

Bulletin 25

NEW YORK STATE SCIENCE TEACHERS ASSOCIATION

PROCEEDINGS OF THE

EIGHTH ANNUAL CONFERENCE

Held at Syracuse High School, December 28-30, 1903

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High School Department

INCLUDING ACADEMIES AND ALL INTERESTS OF SECONDARY EDUCATION

Bulletin 25

NEW YORK STATE SCIENCE TEACHERS ASSOCIATION

PROCEEDINGS OF THE

EIGHTH ANNUAL CONFERENCE

Held at Syracuse High School, Syracuse, December 28-30, 1903

SUMMARY OF SESSIONS

Monday, December 28, 2.30 p. m.

Registration

Opening session; called to order by Prof. E. N. Pattee, Syracuse University

Introduction of President-elect Irving P. Bishop, Buffalo Normal School

Preparation of the Teacher for Nature Study Teaching
Anna Botsford Comstock, Cornell University

Nomenclature of the New York Geological Formations
John M. Clarke, State paleontologist, Albany

Discussion
Albert Perry Brigham, Colgate University
P. F. Piper, Buffalo Central High School

SECTION MEETINGS

Monday, 4 p. m.

Section A—Physics and Chemistry. EDWARD S. BABCOCK, Alfred University, *chairman*

Fundamental Things in Physical Science

HOWARD LYON, Oneonta Normal School

Section B—Biology. Prof. JAMES H. STOLLER, Union College, Schenectady, *chairman*

Correlation of Biologic Science with Drawing and English in the High School

Dr C. STUART GAGER, Albany Normal College

Discussion

HARRIETTE ARMS CURTISS, East High School, Rochester

Prof. J. E. KIRKWOOD, Syracuse University

Correlation of Biology with Sanitary Science

Prof. JAMES H. STOLLER, Union College, Schenectady

Discussion

FREDERICK W. SMITH M. D., Health officer, Syracuse

GEORGE H. HUDSON, Plattsburg Normal School

Section C—Earth Science. AMOS W. FARNHAM, Oswego Normal School, *chairman*

Home Geography. Its Place and Purpose in Geography Teaching

Com'r H. IRVING PRATT, Orwell

Laboratory Work in Physical Geography

ALBERT PERRY BRIGHAM, Colgate University

The Place of Commercial Geography

JACQUES W. REDWAY, Mt Vernon

Tuesday, December 29, 9 a. m.

Section A—Physics and Chemistry. EDWARD S. BABCOCK, Alfred University, *chairman*

Physics, Laboratory and Machine Shop Exhibit

Prof. O. C. KENYON, Syracuse High School

New Apparatus for Illustrating Color Phenomena

Prof. ERNEST R. VON NARDROFF, Erasmus Hall High School, Brooklyn

Demonstration of Radium

Prof. WILLIAM C. PECKHAM, Adelphi College, Brooklyn

Section B—Biology. Prof. James H. Stoller, Union College, Schenectady, *chairman*

Advantages of a Year's Course in Biology (Zoology, Physiology, Botany)

WILLIAM DAYTON MERRELL, University of Rochester

Discussion

WILLIAM L. FISHER, Delhi

Prof. J. E. KIRKWOOD, Syracuse University

Biology as a Culture Study

Prof. W. M. SMALLWOOD, Syracuse University

Discussion

GERTRUDE S. BURLINGHAM, Binghamton High School

Exhibition of a Decerebrized Frog

BURT G. WILDER, Cornell University

Section C—Earth Science. Prof. AMOS W. FARNHAM, Oswego Normal School, *chairman*

Textbooks in Geography

MARGARET KEIVER SMITH, New Paltz Normal School

GENERAL SESSIONS

Tuesday, 11 a. m.

Chemistry in the High School

E. G. MERRITT, Lafayette High School, Buffalo

Desirable Changes in Regents Courses in Chemistry and Physics

G. M. TURNER, Masten Park High School, Buffalo

Tuesday, 2 p. m.

Final Report of Committee on the Effects of Alcohol and Narcotics presented by

BURT G. WILDER, Cornell University

Discussion

Mrs CORA D. GRAHAM, President Woman's Christian Temperance Union of Onondaga County

Tuesday, 3 p. m.

Zoology in the High School

George H. Hudson, Plattsburg Normal School

Discussion

Prof. W. M. Smallwood

Diaphragm Apparatus presented by

Burt G. Wilder, Cornell University

Wednesday, December 30, 9.30 a. m.

Report of Committee Appointed to Prepare a Syllabus for a Second Year of Physics in the High School presented by

Prof. Ernest R. von Nardroff, Erasmus Hall High School, Brooklyn, *chairman*

Discussion

Prof. O. C. Kenyon, Syracuse High School

Prof. William Hallock, Columbia University, New York

Suggested List of Laboratory Exercises in Physiology to be Performed by Each Student

Inspector Charles N. Cobb, Regents Office, Albany, *chairman*

Wednesday, 11 a. m.

A Method of Measuring the Amplitude of Vibration in Stationary Sound Waves

Bergen Davis, Columbia University, New York

The Electrodeless Discharge in High Vacua and the Mean Free Path of an Electron

Bergen Davis, Columbia University, New York

Report of Committee on St Louis Educational Exhibit

Hubert J. Schmitz, Geneseo Normal School, *chairman*

Adjourned

SUMMARY OF ACTION

Alcohol and narcotics. The committee on alcohol and narcotics made a report of progress and, owing to the illness of two members of the committee, asked an extension of time to prepare a final report.

Moved and carried, That the committee on stimulants and narcotics be instructed to present their final report to the council and that the council be authorized to accept or reject the report.

Moved and carried, That the several state educational organizations, the W. C. T. U., and the New York State Central Committee be requested to send delegates to confer with the committee on stimulants and narcotics of the Science Teachers Association to discuss means whereby the teaching in our schools, of physiology, hygiene, and in relation to them, the nature and effect of alcohol and other narcotics may be rendered more efficient.

The committee is: Irving P. Bishop, Buffalo Normal School; Burt G. Wilder, Cornell University, Ithaca; Gaylord P. Clark, Syracuse University; Eli H. Long, University of Buffalo; James E. Peabody, Morris High School, New York.

Physics. E. R. von Nardroff, Erasmus Hall High School, Brooklyn, chairman of the committee to prepare a syllabus for 2d year physics, presented the report of the committee.

Moved and carried, That the report be accepted and adopted for one year, also that the committee be continued for the purpose of further perfecting the syllabus. The committee is: Prof. E. R. von Nardroff, Erasmus Hall High School, Brooklyn; Prof. R. J. Kittredge, Schenectady High School; Prof. Frank Rollins, New York; Prof. O. C. Kenyon, Syracuse High School; Inspector Charles N. Cobb, Regents Office.

Physiology. C. N. Cobb, Regents Office, Albany, presented the report of the committee to prepare a laboratory course in physiology suitable for the high school.

Moved and carried, That the report be accepted and adopted for one year and that the committee be continued for the purpose of perfecting the syllabus. The committee is: Inspector Charles N. Cobb, Regents Office; Miss Katharine S. Wetmore, Rochester High School; Prof. A. D. Morrill, Hamilton College; and Prof. M. S. Thomas, Central High School, Buffalo.

1904 meeting. The council's report contained a recommendation that Syracuse be the next place of meeting. *Carried*

Report of committee on resolutions presented by Prof. J. H. Stoller of Union College.

Approved

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Approved

Treasurer's report

For year ending Dec. 30, 1903

Receipts

Sep.	5	Check from Secretary Warner	$22 48	
Dec.	30	Dues	77 ..	
				$99 48

Expenditures

Oct.	13-29	Shaw, printing	$10 50	
Nov.	19	Stenography (Taylor)	1 ..	
		Express on programs	45	
Dec.	24	Clerk hire	10 ..	
"	26	Letter file, etc	2 15	
"	30	I. P. Bishop	23 62	
"	30	I. P. Bishop	25 75	
"	30	Postage	10 35	
"	30	Incidentals	2 03	
"	30	B. Davis (express)	4 ..	
"	30	Prof. E. R. von Nardroff	2 ..	
"	30	Dr Wilder	5 40	
				$97 25
		Cash on hand		2 23
				$99 48

Committee reports

Auditing committee. We have examined the accounts of the treasurer and find them correct.

G. M. Turner
E. R. Whitney

Approved

St Louis Exposition. Prof. H. J. Schmitz, of the Geneseo Normal School, appointed by the council to represent the State Science Teachers Association on the committee to select exhibits for the St Louis Exposition, presented his final report.

Approved

Secretary and treasurer. *Moved and carried,* That the appointment, by the president, of Mr P. F. Piper of Buffalo for the unexpired term of Secretary and Treasurer A. R. Warner, resigned, be approved.

Section E. *Moved* by Prof. E. N. Pattee and carried, That a section of mathematics be organized to be known as section E.

Nominations. The nominating committee made the following nominations:

President, E. R. von Nardroff, Erasmus Hall High School, Brooklyn

Vice president, O. C. Kenyon, Syracuse High School

Secretary and treasurer, P. F. Piper, Buffalo Central High School

Members of the council, 1907, A. W. Farnham, Oswego Normal; O. D. Clark, George William Curtis High School, Staten Island; J. E. Kirkwood, Syracuse University

Elected

ADDRESSES, PAPERS AND DISCUSSIONS

Monday afternoon, December 28

Owing to the absence of President Hallock, Prof. E. N. Pattee of Syracuse University called the meeting to order and introduced President-elect Irving P. Bishop of Buffalo Normal School, who addressed the association.

Ladics and Gentlemen: Permit me to thank you for the confidence implied in your choice of president. I highly appreciate the honor you have conferred on me, and assure you of my best efforts to further the interests of the association.

From its inception this body has had for its chief purpose the improvement of science teaching and closer cooperation between the Regents, the universities and the secondary schools. Efforts in the first direction have secured in the high schools widespread adoption of laboratory methods, increased interest, and the purchase of apparatus suited to individual work by the pupil. In the other direction cooperation has secured concerted action which is,

in the highest degree, advantageous to all concerned. The high school does the science work for which it has suitable facilities; the college accepts the work as a part of the entrance tests, and is thus relieved of preparation along elementary lines; and the student is enabled either to shorten the time and expense of his college course, or to realize more from his university life. We may therefore congratulate ourselves upon the results already achieved. Success in the past, however, does not permit of relinquished effort. The changed conditions brought about by experience and discovery constantly develop new problems which it is our duty to discuss and, if possible, solve. A few years ago a committee of this body prepared a list of experiments as the basis of laboratory work in physics for high schools. This has been of great value in fixing a standard for both kind and quantity of work. Today, however, we have outgrown that standard and a new one, suited to present conditions, is imperatively needed. The question of a second year in physics, proposed at our last meeting, is well worthy of further consideration. The report of the committee having that topic in charge will be presented on Wednesday.

Perhaps the least satisfactory of all science work now done in the schools of this State is that in physiology. Two committees will present matter bearing upon this topic. I trust that the deliberations of this meeting may advance us at least a step nearer the goal of greater efficiency in teaching, and greater economy of time.

At the request of several members, new and interesting phases of scientific discovery will be demonstrated by science teachers eminent in their own specialties. Through the kindness of Prof. O. C. Kenyon, a rare opportunity will be afforded of seeing practical work in the physical laboratory and in the construction of apparatus by pupils of the Syracuse High School. I am sure that teachers will appreciate these practical demonstrations and will show their appreciation by attending them.

PREPARATION OF THE TEACHER FOR NATURE STUDY TEACHING

BY MRS ANNA BOTSFORD COMSTOCK, CORNELL UNIVERSITY

[Read by William C. Thro, Cornell University]

Since the beginning of the nature study movement the one great obstacle to the introduction of nature study in the schools has been that the teachers were not prepared to teach it, and were afraid to undertake it. It has been demonstrated over and over that nature study in the schoolroom saves time and energy and temper for the teacher and pupils. Everywhere we have seen that the children are more than interested in anything that has to do with the myriad life out of doors, and that they draw and write about nature study subjects so easily and naturally that they are quite unconscious that they are engaged in either drawing or language work. Now there is no stumbling-block left in the nature study path except the unprepared teacher. She is overworked anyway, and she is afraid to try any new thing that involves extra work and possible failure. She takes arithmetic or grammar or geography as a criterion; she knows that unless she has mastered these subjects it is not safe to try to teach them. Therefore, she concludes that unless she masters all physical and biologic science she dare not begin nature study. The fact that no one nowadays pretends to have achieved such mastery does not seem to influence her in the least.

We have visited many schools and have seen much nature study carried on in the grades, and from our experience it seems to us that the teacher does not need to know so much about nature to be sympathetic toward her children in their study of nature. The following instance occurred in our own town: for some years some of my child friends had talked to me most enthusiastically about their nature work with Miss Brown, and these little people surely learned a great many interesting things by getting the answers to their questions direct from nature. I concluded that Miss Brown must be specially well trained in this line of work.

Later I came to know her well, and a person more guiltless of nature knowledge than she I have seldom met. She hardly knew a daisy from a sunflower, or a moth from a butterfly, and could not even tell the English sparrow when she saw it; in fact, she knew about as little as possible, and not nearly so much as did her pupils who had talked to me about her. But she had a sweet outlook on the world and loved her children, and knew how to encourage them to advance along the lines of their own interest. She had the right kind of spirit and that seems to be of more importance than knowledge in teaching very young children. However, there is no question but that she would have been a far better teacher had she had more knowledge.

Another thing we have come to believe is if a teacher be interested in just one phase of nature she is likely to be a good nature teacher. Nature extends to us a beckoning hand from every bush and flower, and stick and stone, and it really makes very little difference which hand we grasp in greeting. This fact is the most hopeful one in the whole nature study outlook. A teacher may become interested in just one line of out of door study, and this interest is the key which unlocks nature's storehouse. Therefore, when a teacher is thinking of fitting herself for work in nature study we always encourage her to devote her few spare moments and small surplus energy to knowing some one subject more or less thoroughly. We encourage her to study the flowers, or the trees, or the ferns, or the birds, or the butterflies in a masterful way. It gives a sustaining interest to all of her work; it is the thread on which she strings her beads of nature knowledge.

Let us suppose that our teacher begins with a slight interest in a subject; the question is how can she best gain more knowledge, what kind of facts should she seek to know? First of all she should understand the principles which underlie her subject. The knowing of species by name is the merest introduction to real work. To illustrate: suppose our teacher's interest is in flowers or trees, first of all she should know a few fundamental things about plant physiology. She would know that (1) the roots of a plant serve to get it nourishment from the soil and that they

also serve to hold it in place; (2) the stem or trunk or branches are for the purpose of holding the leaves out to the light, and holding the flowers out where they may be pollinated, and they serve as channels for the sap also; (3) that the work of the leaf is threefold, that it manufactures the food for the plant, digests it and helps in the respiration; (4) that the object of the flower is to mature the seed, for the success of the species depends upon the maturing and scattering of the seed; (5) that the soil, and water, and light and air are absolutely necessary to plant growth; (6) the nature of the seed and how it behaves while germinating.

Now all of these facts just enumerated she could commit to memory in five minutes, but such facts are not really learned by memorizing. The teacher should know all of these facts by experiment and observation not only in the study of one species but of several. There is a most valuable little book written by Professor Atkinson that tells of many simple experiments which prove all these things in plant physiology. She should carefully conduct these experiments and see for herself what is true. Above all she should think of each plant as a living being and consider its needs as she would the needs of a pet animal or a child. A fact in nature simply learned by rote means nothing. The facts about life have to be lived with in order to become significant. Our teacher accepts without question the fact that sap does ascend the stems of plants, but let her place the cut end of a stem in red ink and later study it in cross section and see the red track of the fluid; if she has done this she will know that sap ascends. So it is with all the simple facts of plant existence. If she can only be induced to investigate these things and see for herself that they are true the battle is won.

Supposing our teacher wishes to study birds, how shall she go about it? First of all let her emblazon on her banner this motto, "A bird in the bush is worth two bird books in the hand." Let her begin by observing some one bird, the more common the better. In fact, I think she might teach almost all that one needs to know about birds by studying the chicken and robin and contrasting their form and habits. Again she must come, by thinking and

observing, into the comprehension of the principles which underlie bird life. She should first of all consider her bird in relation to its life and environment. What is its food; how is its form adapted to get this food? She should begin by thinking about the life of the bird; it flies, or walks, or hops or swims, why does it have these methods of locomotion? Because it must search for its food. Why do birds migrate? It is not because they could not endure the cold, but because the frost kills the plants, and the insects in turn disappear and the bird has no food here in the snow-covered north in winter; therefore it must go many miles south where it can find food; to do this it must have a rapid method of locomotion and therefore, it has wings. Let her study the form of each species of bird that she knows and ask the reason for its peculiar development. The beak of the chicken is made to go with its feet, that is, feet that scratch and beak that picks up food in the ground. The woodpeckers feet and beaks are also correlated, the feet arranged so that the two toes extend forward and two toes backward to hold the bird firmly on the bark while he uses his long, sharp beak as a chisel, to make the passage way through wood to the hidden insect. The feet and the beak of the duck are also correlated, the feet webbed for water life and the broad bill fitted for snatching the food from the pond bottom. When she notes that the young chicken is covered with down let her ask why the young robin is not likewise clad, and so on and on let her always question why as to the bird's form, and answer by the bird's habits. There are two books that help pupils in this line of thinking, the *Bird Book* by Mrs Eckstorm and the *Story of the Birds* by Baskett. If she once gets into this way of thinking about birds she will soon notice the different species and notice them not because they are different species, but because their habits are different and she is interested.

And this should be the method of training for the nature study teacher in every biologic science. She should be made to comprehend the great simple facts of life and from this basis study its variations. I think I hear some of you say, "This is all very well, but how is a teacher to get this kind of training?" There are

several ways in which she can get her start; she may attend normal schools or colleges or some of the summer schools and select one study and devote her time to it instead of taking a dozen studies and giving no proper time to any. She could get some help of this sort from the Cornell home nature study course, for this work is carried on on this basis. She could take one or two wise books like the ones mentioned to suggest lines of thought and then, think and observe for herself. Wherever she gets her start, if she ever does any good work it must be from her own thinking and observation. Only by thinking can she master the real meaning of her observations. One of the very hardest things to teach a beginner in nature study is the value of a perfect and simple observation. If the teacher is the right kind she will at once see the relation between her own observations and their importance in the schoolroom. She will see how she can use each new fact to give the child a greater interest in his work, and she will see at once how to use it in making the regular work of the school stronger.

NOMENCLATURE OF THE NEW YORK GEOLOGIC FORMATIONS

BY JOHN M. CLARKE, STATE PALEONTOLOGIST

I have been asked by your president to speak briefly on the matter of the current nomenclature of our geologic formations, to indicate its underlying principles and explain the apparent tendency to a multiplication of its terms. In doing this I feel it should be a part of my effort to assuage the apprehensions of such of our teachers of geology as have felt embarrassment at what may seem to them a needless, but what is actually an unavoidable augmentation of terms.

Doubtless this request has been made of me because I am looked upon as the chief offender. Certainly we have been guilty of revising this nomenclature and of promulgating trouble thereby for all teachers of the science, and I am particularly glad to have this opportunity to come before you and give my answer to such questions as those which I fancy are in your minds: Was not the old

and time-honored nomenclature good enough? We were used to it, had been taught it ourselves and it had stood the test of years; it was, compared with what you have proposed, a simple nomenclature, easily assimilated, readily understood and applied, and indeed it seems to have served the purposes of even professional geologists. What need was there of the suggested changes? Were they called for by geologists? They certainly were not by the teachers of geology.

In inviting you over to our point of view I propose to give a very brief account first of the historical development of this nomenclature. It is not without interest, and even has its tragic side.

Let me premise all I have to say with this statement. The "New York series of geologic formations" is an historic monument, erected by the labors of devoted workers, and fortified by the unequaled investigations continued through more than a half century of that most zealous and distinguished paleontologist, James Hall, a figure which towers in the history of American science. It is and has been for decades a standard of reference for all students of the older rocks throughout the world and while other classifications proposed for these rocks, contemporaneously or subsequently, have fallen to the ground, it has withstood all the attacks of time.

When the Geological Survey of New York was closed in 1843 by the rendering of the final reports (and I may add that there has been no geologic survey of the State, organized with this title, since that date) there was a general concurrence of opinion among the geologists as to the mode of arrangement and grouping of the formations, disturbed only by the individual expression for or against propositions effective in one district but less pertinent in another. It will be recalled that for this survey the State was divided into four districts and to each a geologist with assistants was assigned: Lieutenant Mather in the first, or southern, Dr Emmons in the second, or northern, Lardner Vanuxem in the third, or central and James Hall in the fourth, or western. During the first year of the survey the division between the third

and fourth districts ran east and west through western and central New York, the third district being at the north and the fourth at the south of this line. The first assignment gave the original third district to Conrad and the fourth to Vanuxem. But the first year's work showed the impropriety of this division as it gave to neither district a complete representation of the succession in this part of the State. In the arrangement of districts as they were finally reported on, the third and fourth were separated by a north and south line passing through Cayuga lake. At the end of the first field season of the survey Mr Conrad withdrew to become the paleontologist of the organization and Mr Hall, who for that time had been assistant to Dr Emmons in the second district, was appointed district geologist in charge of the new fourth.

Geology in New York had not been without its active devotees before this period. It was to the personal and scientific influence of Amos Eaton of the Rensselaer School at Troy more than to any other one man that the organization of the geologic survey was due. Eaton was a pioneer in geologic science in this country. Under the tutelage of Stephen Van Rensselaer he had made a geologic survey of the country adjoining the Erie canal, he had published textbooks on this as well as many another science, and he had applied his own terms to rock formations whose courses he had defined. When therefore the four geologists, one a pupil and one an associate of Eaton, came to determine the nomenclature of the rock formations, they found outstanding a number of Eaton's terms, such as Corniferous limestone, Birdseye limestone, Calciferous sandrock, which they forthwith adopted into the proposed scheme, after having more clearly defined their boundaries. In each annual report the geologist made use of local terms intended to serve a provisional purpose and immediately applicable only to their own districts.

In the valley of the Schoharie creek the Gebhards had, between 1820 and 1835, worked out the succession of strata in that remarkable section, collected their fossils and proposed their own strati-

graphic terms, and some of these, Pentamerus limestone, Tentaculite limestone, remained.

The concurrent sentiment of the geologists then as to a nomenclature included terms variously derived. Thus there were quarrymen's names, like Birdseye limestone, terms which had reference to the lithologic character of the strata such as Corniferous limestone, Calciferous sandrock, others that denoted organic characters, like Pentamerus limestone, Delthyris limestone, Cauda galli grit and many terms taking their origin wholly from the localities of typical exposure, like Potsdam sandstone, Trenton limestone, Rochester shale, Marcellus shale, etc. Fortunately for their perpetuity these last named terms were in great majority.

These original terms were the designations of the geologic units. It is important to keep this fact before the mind that the classification of the New York system was primarily and essentially a subdivision into unit terms. It was not the purpose of the geologists to group these lesser terms except in the broadest sense. Some of them did a little of it. Hall for example employed the terms Hamilton group and Portage group but he did not duplicate the unit terms in so doing. On a major grouping of the unit terms they did however agree and promulgated with essential unanimity the great divisions of the series into four parts, to wit: Champlain, at the bottom, Ontario, Helderberg and Erie.

Here were four groups of stratigraphic integers well defined, firmly grounded in fact and which might have become as fixed in our general usage as the terms Trenton limestone and Utica shale, had the successors of the original survey stood loyally by them. There was intruded on New York and American geology at this time the influence of English geology. Sir Roderick Murchison, disciple of William Smith, director of the Geological Survey of Great Britain, president of the Royal Society, had introduced the terms Silurian and, with Sedgwick, Devonian. Sedgwick at Cambridge, at first collaborator with Murchison, then his active opponent, had also introduced the term Cambrian. It is not necessary here to enter on the differences of opinion that have prevailed among the followers of these two eminent men as to the sub-

division of the Paleozoic, but in America and specially in New York there was no place for either the contention or the classification. Nevertheless Murchison's great influence on the science of his time prevailed here as it has elsewhere. Who among the older teachers of geology here has ever heard of the Champlain group as applied to the Lower Silurian, or Ontario group applied to the Upper Silurian? You have used the term Champlain for postglacial deposits and time, and may have heard, I hope not have used, the term Ordovician for Lower Silurian. The four geologists actually builded better than they knew, for their fourfold major grouping was better adapted to the conditions in New York than the superinduced English nomenclature could be.

We have not tried to abolish or discard the classical English terms; that would be unwise and probably futile for, for broader divisions, we must speak in terms of worldwide meaning. But guided by a feeling of loyalty to our predecessors, by a conviction of the preeminent right of New York to these terms and of the unimpeachable appropriateness of them we have renewed our suggestions for at least alternative use, so far as present conditions permit. Thus we should say alternatively, Silurian or Ontarian, or to conform with recommendations of the International Congress of Geologists, Siluric or Ontaric. We should not say, however, Lower Siluric or Champlainic but always Champlainic, for the original Silurian was only what is now known as Upper Silurian. Two great systems have been combined under one name and designated as Upper and Lower. This is a condition which it has been attempted by English geologists to palliate by the introduction of the word Ordovician for the lower division but there is no place for this term, it is not recognized by the late director of the British Geological Survey, Geikie, and certainly should not be in America while Champlain is the older and better word. We are therefore employing the term Champlain in its original use whenever circumstances permit, that is, in our more technical papers where it will meet least resistance, confident that it will gradually find its way back into general acceptance. Of the other terms of the major series it may not be possible to save all for

the advance of the science and the requirements of detailed correlation have indicated that in some cases these divisions embraced heterogeneous elements, as the Erie which included both Middle and Upper Devonian or two faunas having little in common, and the Helderberg which included both Lower Devonian and an aberrant part of the Upper Silurian. In these cases we have endeavored to save these terms to the New York nomenclature by restricting them to a sense in which they can be used.

It is here necessary for me to advert to that fact that a seriously disturbing element in the nomenclature was introduced by the influential textbooks of Prof. J. D. Dana. These fine books were in general use among students up to 15 years ago and in many places are still preferred to all others. Prof. Dana's effort to group the New York units was doubtless for the purpose of simplifying the subject to the student. The geologists, as I have said, introduced only in a very few instances a combination of the units into groups of the second degree. Under the term Erie division Hall did propose the name Hamilton group composed of the Moscow shales, Encrinal limestone and Ludlowville shales, but Dana so changed this particular group of the second order that his Hamilton group embraced the Marcellus, the Hamilton and the Genesee shales. It is thus that the term Hamilton group is generally understood and generally employed today. This secondary grouping of stratigraphic units is always of very minor importance to both student and investigator. It is the units themselves that are vital. But Dana's group terms duplicated in almost every case a unit term. There was the Trenton, the Niagara, the Corniferous or Onondaga, the Hamilton, the Chemung, etc. redressing in broader sense terms already employed as units. The adoption of this usage has been a source of endless confusion to investigators and of some distress to students. It is a practice now wholly discountenanced and discontinued by geologists to employ any local term, and local terms are alone acceptable to the science at present, in a double sense; to apply it to a lithologic or stratigraphic unit, that is, to one of the integers in

the succession of rocks, and also to use it in a broader sense embracing a number of such units.

When we took up the restudy of our formations it was at a time when active operations were progressing in the Paleozoic rocks in other states. If we had not introduced substitutes for the terms of the second order, using for them names derived from typical New York sections, the geologists of Maryland, Virginia, Ohio or Pennsylvania might have done it for us. It would have been a very slender gratification to our pride in the work of the original geologists of New York to have seen, for example, the term Hamilton group laid aside and replaced as had been proposed, by the name Romney group, a Virginia term. I desire to repeat the statement that these combinations of units into groups of the second order are pure conventions highly subject to variations in their limitations but designed chiefly to express the continuation of a given assemblage of organisms through a series of differing sediments. Thus the term Ulsterian group conveys the idea of the perpetuity of essentially one fauna through the arenaceous Esopus and Schoharie grits and the highly pure Onondaga limestone while this fauna differs from that of the Oriskanian group beneath and of the Erian above.

The scheme of classification promulgated by the four geologists was inharmonious in one essential particular. Dr Emmons, the senior of the body, a more practised geologist, a founder of the Albany Medical School, professor at Williams College and at the Rensselaer School, believed that he had found in the disturbed and complicated rocks of eastern New York which were within his district and in western Massachusetts where he was much at home, an entire system of strata lying on the crystallines and in his belief beneath the Potsdam sandstone. It was he himself who determined the Potsdam sandstone so highly developed in the western part of his district, as the base of the stratification there, and which was accepted by his colleagues as the basal element of the New York series. But in eastern New York through the region of Washington and Rensselaer counties and the Taconic hills he convinced himself of the existence of a great thickness of

rocks, determined by stratigraphy solely, as older and lower than the Potsdam, and this he proposed to call the Taconic system. In this view his colleagues would have no share. They delegated Vanuxem, a careful and judicial observer, to go over the evidence. Just then Sir Charles Lyell, who had acquired a very influential position in English geology, on a tour of the States, visited New York and was interested in what had now become a controversy. He too visited the field under the guidance of Vanuxem. The decision was opposed to Emmons's view—the Taconic system so called was but a mass of altered and disturbed Silurian. It was ruled out of all reports except Emmons's. But Emmons stuck by his convictions. When the survey's geologic map was issued he issued another with the Taconic system colored in.

The reports of the geologists published and the survey concluded, it was believed to be, as it was indeed, of supreme moment for the perpetuity of the classification, that the study of the immense wealth of accumulated fossils should be continued. This Emmons desired to do, no doubt seeing therein an opportunity for vindication, but he was no match in political astuteness for his younger colleague, Hall—few men were—and Hall took this work, while to Emmons was assigned the preparation of the agricultural reports. In these however he found the opportunity to fully exploit the Taconic system in New York and therein he published accounts of some of its fossils. His claims received no hearing. His determinations were either ignored or pronounced impossible, he was castigated by Silliman in the *American Journal of Science* (the leading scientific review), he was persecuted by the geologists of his own State, dragged into the Albany courts by a former colleague and mercilessly assailed on the witness stand by Louis Agassiz. The fire of scientific orthodoxy burned hot in those days and kissing went by favor then as now. Ignored, persecuted and treated with contempt Emmons was virtually driven from the State of New York, but with undaunted spirit still firm in its convictions, he devoted other years to the elaboration of his Taconic system in its southward extent along the Appalachians, even up to the date of his too early death in North Carolina.

For 50 years after its announcement the term Taconic system was barely mentioned in American science. The student of geology would have known nothing of it from the textbooks of the time and I for one completed my preliminary training in the science without ever having heard of it. It was a conspiracy of silence broken now and again by a diatribe from the *American Journal of Science*. Not till 1896 when the last of Emmons's geologic contemporaries and persistent opponents passed off the stage, did the air become clear and the ground free for a judicial discussion of his propositions.

Emmons was right. There is a great system of rocks and a great series of faunas in New York below the Potsdam sandstone. Such a series of strata was located by Sedgwick in Britain at even an earlier day than Emmons's and was called by him the Cambrian. Over this word and its bearings was waged still another controversy as warm as that in America. Subsequently the remarkable fauna of these primordial rocks in Bohemia was depicted by Barrande but by the testimony of Barrande himself and in the honest knowledge of all geologists it was Emmons who first showed from its fossils, the only infallible guide, that the Taconic system was earlier than the New York series and does include strata of immense thickness and tremendous importance because of their carrying the first known organisms of the earth. To Emmons and New York then belongs the honor of this discovery. From a sense of loyalty to our State, of justice to a great geologist greatly wronged, from the fair claims of priority we ought to employ the term Taconic in preference to Cambrian. During the dead years of silence from 1860 to 1890 the latter word gradually came into use and though not employed at all now in its original sense it may nevertheless become difficult to displace it.

I hope it has been made clear that the prime motive and purpose in our revision of the New York nomenclature of the geologic formations have been those of loyalty to the landmarks which our fathers set up, to prune off, so far as circumstances would permit, an intrusive overgrowth on the foundation stones. The classifi-

cation by the original state geologists was prophetic and almost ideal; it was adjusted to the known facts and flexible in adjustment to those since become known. Its integrity was marred by later propositions from without and threatened by improper combinations. Our efforts have been directed to rooting out these adventitious growths. Our propositions have only the appearance of novelty, for the less correct usage had become so firmly ingrained that it seemed authentic. We have endeavored to return to the simple usages of our distinguished founders.

As I speak of simplicity I can almost hear the smile which greets the expression as some of you recall our present record for the multiplication of geologic units, and this brings me to another, a very different and highly important phase of our subject, from which the motive of loyalty to the historic past is necessarily eliminated and where the demands of the active progressive present control. We have greatly increased the number of unit terms in our classification. They have now become so numerous that taken as a whole and at any one time, in my judgment and I doubt not in yours too, they can hardly fail of being an embarrassment and source of confusion to teacher and student alike.

The geology of New York has not remained stationary since 1843. It is 60 years since the original survey was closed but the work of analysis of our formations and their faunas has gone on during all this time without an interruption. The body of fact thus accumulated is enormous, the knowledge of our formations and their faunas most refined. New York has become a fountain head of knowledge of the older rocks and of the earliest assemblages of organic remains to appear on the earth. It should be a matter of pride to us all that New York is more accurately known paleontologically and geologically, than any equal area on the western hemisphere. I will go even further. Last month I received a letter from the most distinguished of French geologists in which he exclaims: "The work of the geologists of New York has made the paleozoic formations of America better known than those of the Old World."

When the waters of the great Appalachian gulf of Devonic times were depositing the sediments of the Portage group they laid down sands in eastern New York along an estuarine and brackish bottom, through central New York ran the littoral zone of prolific marine life, in western New York was deeper water with black muds among the fine and coarse grained silts. In eastern New York the organisms of the rocks are estuarine and wholly unlike the profuse littoral fauna of central New York and these again fundamentally and entirely different from the fauna in the Portage rocks of western New York. These three distinct faunas represent three distinct geographic or bionic provinces and yet they were absolutely contemporaneous and the strata containing them are essentially continuous across the State. There is but one method of procedure in setting forth this condition in stratigraphic nomenclature. Each province must have its own series of terms and multiplication of units is required for precision of expression. All are Portage—there is but one Portage time the world round—but all are not the same Portage, one may be Oneonta, one Ithaca and one Naples. What is true in such a case is equally true in others. The old stratigraphic divisions are losing none of their integrity but their more refined study continues to bring out differences of expression in fauna and in rock composition which for the exactitude of our science, for the proper handling of our problems can only be expressed by additional local terms for minor divisions. Hence we have multiplied these in some measure. Progress will demand that they increase rather than lessen. We are not seeking opportunities to augment this already formidable list but when the necessity arises we can not only not fail to recognize it but we also can and do endeavor to keep out extra-New York names.

On account of the peculiarly long east and west coast line in New York during the period of deposition of the old rocks our classification is gradually becoming a nomenclature according to meridians. That of eastern New York will not concur except along broader lines with that of western New York and this

divergence of expression in terms is bound to grow with the progress of knowledge.

If I have now indicated in a broad way the basis and principles of our classification let me add in the way of suggestion: No one will carry all these terms in mind. I have a list of them constantly on my own desk. Instruction in geology is little without local application and the increasing refinements of our system will help to illumine the local geology as the broader terms alone could not. Supported by an acquaintance with the grand divisions, the unit terms become to the student a guide for home use. It need not concern him what the array of units may be in some other meridian of the State. They are not for practice in mnemonics and they will not appear among the questions on the Regents examinations, but they are the names of the successive pictures which portray the wondrous story beneath our feet.

Albert Perry Brigham—I approach the discussion of Dr Clarke's paper from the point of view of a teacher, quite aware that he, as an expert authority, may see good reasons for changes which must be adopted slowly, if at all, by the teacher. Perfect uniformity in the usage of all persons and at all times can not be expected, because geology is a growing science. Thus our knowledge of the Cambrian has vastly increased and its rank as a time division has changed during the past 20 years. The time divisions are not sharply defined, indeed they shade into each other because formations and faunas came into existence by processes of evolution in which sharp transitions are few. The history of England or of America is coming to be taught, not by reigns or administrations, but by what are, on the whole, periods of national or social unfolding, and no two historians are likely to be in exact agreement in their drawing of limits.

Thus changes in nomenclature are sure to come, which means that names will be used longer by some than by others, that misunderstandings will arise, and that the fittest will survive. The rest will be embedded in the older literature as fossils in the rocky matrix, to perplex the reader or stir the interest of the historian of our science. Thus names will be tested by

their usefulness and agreement, if it ever comes in any degree, can not be arranged offhand, but must grow.

It is a safe principle that the textbook should be conservative in making changes. If the author is sure a change is needed, and is in full accord with truth, he must make it, no matter how much he puts us to inconvenience, but he should hold the old name for a time, to preserve the connection and tide the learner safely over into the new usage. If he is in some doubt of the necessity of change, but regards it as probably wise, he may keep the old in the first place, but bring in the new as a possible alternative, to be tested in the course of time.

Without question, local geographic names must replace mineralogic or accidental names, for the smaller units of formation and the briefer time intervals. We must have a place name, of a type formation, which can be visited and identified by any one. Thus Calciferous is most properly replaced by Beekmantown, Corniferous by Onondaga and Birdseye by Lowville. The old terms are merely unhappy exceptions to that general policy of the older geologists in our State, which did so much to make the New York series a North American standard. In the end, Beekmantown and Onondaga will be as familiar and as full of meaning as is Trenton, Medina, Hamilton or Chemung.

My own preference as a teacher is for three and but three orders of time interval. I would say era for the major divisions, period for those of the second order, and epoch for those shorter divisions which may be fairly expressed by the rocks and fossils of a single locality. Subordinate place names might be needed for various expressions of type, and these can be multiplied so far as found useful.

The epoch names would of course, vary with the region, as from New York to Iowa or the Great Basin. Some important or persistent formations or faunas, like the Trenton, might and would give the local name wide currency, as would the early adoption and prolonged use of such a name.

Finally, the teacher need not teach with equal insistence, all the nomenclature of the book. For my part, in elementary work,

I should have the eras and periods pretty thoroughly learned, because they are important and because broad pictures of their life and their geography can be drawn, and made more or less real to the student. But the lesser divisions should be taught in detail only as a few of the type localities can be actually visited or are personally known to the class. Fortunately for teachers in our State, the places are few where the student can not see two, three, or half a dozen type localities and he can thus learn in a real, even if incomplete way, the principles of all geologic succession.

P. F. Piper—The matter of the classification of the rock formation is a very important matter to us in Buffalo for much of our work is done in the field. Within a radius of 20 miles we have sections of all the local rocks from the Medina to the Portage. Our pupils are required to make not less than five class excursions to the neighboring quarries and gorges. Written reports and sketches of physiographic features are made by each member of the class. It is just here that the question of nomenclature comes in. We have the rocks and the fossils with us always, but the names of the formations may not be the same from one year to another.

That geology is a progressive science is proved by the fact that our present schemes of classification are not permanently established. Teachers will welcome any changes which may simplify the existing confusion due to the difficulty of correlating the terms proposed by the students of the subject. While welcoming these changes, conservatism would suggest that old classic terms should not be displaced if it be possible to retain them. The mere retention of a name for the sake of the name, or because of local pride, or in order to honor the memory of former masters of the science, is unreasonable and absurd if a more exact modern term would better meet the requirements of the science.

In some cases it is not clear that a change is for the better. The term Niagara is a case in which the substitution of Lockport would not be an improvement. Trenton is equally well known and only serious objection to its continuance by competent author-

ities should warrant its displacement. There would be little, if any, objection to the reintroduction of Taconic or the other terms suggested in Dr Clarke's admirable paper. The teacher can readily adopt the new system of classification for class use, for the pupils can learn one scheme as well as another. Unfortunately the textbooks can not be so easily changed, and the mature as well as the immature student is greatly confused by his inability to correlate the two systems. There should be some compromise and an agreement as to the major units and the Regents should not hold pupils responsible for anything else except the local subdivisions in the immediate vicinity of the school. We wish to thank Dr Clarke for the very valuable work he has been doing and we desire to cooperate with him in every way possible.

Monday afternoon

SECTION MEETINGS

Section A. PHYSICS AND CHEMISTRY

FUNDAMENTAL THINGS IN PHYSICAL SCIENCE

BY HOWARD LYON, ONEONTA NORMAL SCHOOL

As physical science must be regarded as a foundation on which other science is developed, or, rather, as other science in the light of recent knowledge seems to be but a continuation of the study of physical science, it is important that this foundation be laid well and strong.

One who surveys carefully the field of popular physics is surprised to find that the number of fundamental ideas and principles is very small, and if a teacher has instructed his class thoroughly in these he is quite apt to be disappointed by the seeming meagerness of his work. However, no effort contributes so much competency in students as thorough grounding in those conceptions that form a basis for larger thought.

Ideas should be driven home by repeated examples, by questions, by experiments, and specially by constant appeal to early experience.

I take it that the work in physics in the high school and in the first year or two of the college course has to do largely or wholly

with thorough instruction in what may be termed familiar principles such as were worked out with great care by early investigators and such as have to do with the phenomena of everyday life.

In glancing over the large array of new texts in physics one is impressed with the idea that these works are leading students farther and farther away from the always attractive and severely plain works such as the old *Comstock's Natural Philosophy*. Newer works are very fascinating to one who has become familiar with the facts simply stated of the older writings, but are bewildering to the student who has just begun his study of physics. It seems a matter of regret that we no longer have such an illustration in physics as Pascal's bursting cask, for that picture kept one wondering till he finally understood the principle of hydrostatic pressure. We miss, too, the picture of Franklin storing his Leyden jar with electricity from the clouds. Perhaps the vague notion in the mind of bookmakers is that the picture would thwart the tendency of the modern student to discover for himself the relation between the cause of lightning and electricity.

It would seem sometimes as though we were assuming that the children of this later day were quite as wise as the mature Archimedes. As a matter of fact it requires a good deal of drilling of an 18 year old high school student to give him a sufficient grasp of Archimedes's principle to last him six months.

My wish is not for a return of the good old days but for a continuance of what was valuable in early teaching. The older books contained but few elementary principles, but these were effectively illustrated by word and graphic pictures. Perhaps an analogy may be found in the old time reading of very few books but reading these thoroughly.

The superiority of students trained in the meagerly equipped country schools over those who are given the advantage of splendid city high schools confirms our opinion that long contemplation of relatively few objects of interest furnishes a better means of strengthening the mental processes than acquaintance with a maze of bewildering sights.

My acquaintance with papers in physics and chemistry of candidates for state life certificates in New York State convinces me that the amount of definite knowledge shown by high school, normal school, and college students is often all too meager to merit the conclusion that these students are fairly educated.

If the question calls for a drawing and explanation of the principles of the telephone, there is presented a nebulous picture with a few remarks to the effect that, as the person speaks into the transmitter, a thrill of vibration agitates a hundred miles of wire with a message of sympathy to the distant listener, all of which rather suggests that our critics are wrong who begrudge us the time devoted to physics that it may be employed in the humanities.

It is not my purpose to facetiously criticize the results of the teaching of physics, but I know from the perusal of papers coming from the various quarters of the State that sound training in fundamental things is not all that could be desired nor all that is possible.

To better illustrate my contention that students of science are wofully deficient, at least those who are striving to obtain first grade or life certificates for teaching, I will read a few actual answers.

To the question calling for an illustration of the fact that a vacuum will not transmit sound the answer was:

"Put a man in a zinc box, exhaust the air, and make him holler."

Another answer: "A planet has a tendency to move backward in its orbit. This is known as the planet's retrograde motion."

"Roemer discovered the velocity of light by observing Jupiter's satellites and noting the time that elapsed after the satellites were discovered with the telescope before they were first seen by the naked eye."

"To repair a dislocation requires two persons, one to hold the leg and the other to pull it."

The properties of nitrous oxid: "If breathed for a short time it produces unconsciousness from which however the victim recovers with shouts of laughter."

What can be done to improve the teaching of physical science?

I would first urge the judicious selection of topics of study by the application of common sense to the adaptation of the course of work to the experience and interests of youth.

A prominent teacher of physics remarked to me recently that a certain city that chose its instructors by competitive examination wholly was, in his judgment, making a serious mistake; for men with doctor's degrees were taking the positions and attempting often to do just the work in physics or chemistry that last engaged their own attention in the university. He believed that plenty of men and women could be secured who had been tried thoroughly in the schoolroom and whose power to adapt work had been abundantly proved.

I am acquainted with two teachers of more than average ability who have been trained in a leading university and who did the work in physics in that institution entirely to the satisfaction of their instructors, who say that when they began to teach they knew almost nothing of simple high school physics and were at a loss to know how to begin their work. They had been working on constants and coefficients and specific values whose meaning they only vaguely comprehended, and training in popular physics had been neglected.

However, much work of the sort mentioned above is needed in the technical schools. It is evident that the average citizen should be trained first in the physics of the lever, of fluid pressure, of expansion by heat, and of kindred familiar principles.

It is by no means true that physics and chemistry are not finely presented in many schools.

I have just had the pleasure of inspecting the splendid work in science of such institutions as the Teachers College in New York, of the Erasmus Hall High School, and Pratt Institute in Brooklyn, of the Binghamton High School, and similar institutions and I found in these places a real delight in scientific research shown by the young men and women in attendance.

Here and there in small union schools I know that superior instruction is afforded in science, because teachers possess the

knowledge and tact to adapt work to the student seeking instruction.

At the Teachers College I saw working models of hydraulic elevators and of other commercial devices in use about the institution, all of which illustrates the point that I would make, namely, that the study of science should afford explanation of the devices and phenomena that are right at hand and familiar to the experience of those taught.

The preface to the first edition of J. Dorman Steele's *Fourteen Weeks in Chemistry* says that the author "has not attempted to write a reference book lest the untrained mind of the learner should become clogged and wearied with a multitude of details. Unusual importance is given to that practical part of chemical knowledge which concerns our everyday life, in the hope of bringing the schoolroom, the kitchen, the farm, and the shops into closer relationship."

With such a purpose on the part of the author, it is fortunate that his works won so large a measure of popularity.

I will confess that I have but little interest in those queries that run: How can a student be best prepared to pass college entrance examinations, or Regents examinations, or examinations licensing candidates to teach? I believe in that sort of common sense preparation that will enable one to pass any reasonable examination through acquired ability to reason, and sound and definite information.

We are here to discuss the best methods of teaching that we may fit students to go on to larger study or to take up intelligently the still larger problems of life.

Our task is distinctly that of laying a good foundation.

We would be disappointed indeed if work in a normal school which has reference to preparation for teaching did not fit students as well for the problems of the college, or technical schools, or business life.

We have students, to be sure, who are at the bottom of their class, but General Grant found just such conditions at West Point.

A gentleman told me of an experience which he had with a

high school teacher who had been trained in a leading college that would show that even with such preparation one might be lamentably weak.

This young man told his principal on one occasion that he could not make a common electric bell work and he asked for help that he might be able to explain the apparatus to his class the following day. When the principal investigated the difficulty with his assistant, he found that the young man had run two wires from the poles of his electric bell to the poles of a horseshoe magnet. And the bell wouldn't ring!

I am quite inclined to think that exercises in the laboratory that have for an object the determination of the coefficient of torsion could better be given when a student has occasion to apply this principle to torsion in the suspension fiber of a galvanometer. Problems relating to bending effects produced by additional weights on bars of wood could be left to the technical schools.

With the possibility of wearying some who have closely thought out their line of work, but of helping others to determine the best course, I will ask the forbearance of the former and give what seem to me fundamental things in the various departments of physical science.

Mechanics. A general conception of matter, mass, and weight; the tendency of masses and molecules to approach one another—called gravitation and cohesion; cause of motion in matter—simple and resultant forces; character of motion under the action of momentary and continuous forces; force acting through space—energy; "action at a distance" and the relation of impelling forces to distance; the equation of the machine in action as the product of the force by the distance through which it acts and of the resistance by the distance through which the resistance is overcome; pressure in fluids; the product of the area of a surface subjected to pressure by the average depth of the surface by the density of the fluid.

Heat. Yielded by arrested mechanical motion, chemical action, and radiation; causing expansion; means of distribution; units; in relation to the phenomena of liquefaction and vapor-

ization; relative capacity of bodies for absorbing heat; the equation of exchange; heat units absorbed equal to the heat units supplied; mechanical equivalents; applications.

Sound. Motion of wave and mutual action of waves; mediums for transmission and velocity; intensity and distance; reflection; character of sound determined by frequency of vibration; the musical scale; pitch as modified by tension and the quantity and nature of matter; musical instruments.

Light. The ether, its waves, and their mutual actions; intensity and distance; relative obstruction offered by different kinds of matter to light waves; the laws of reflection and refraction in explanation of familiar phenomena; separation of dissimilar waves and the phenomena of color; polarization.

Electricity. Static charges with a view to illustrating the idea of quantity, density, and potential, and of electricity as a measurable thing; points differing in potential connected by a conductor as a condition necessary to produce the so called current; degrees of electrical resistance in bodies; ways of producing difference of potential and the work of currents, specially heating, electrolytic and electro-magnetic effects; Ohm's law and the definite units involved; the determination of resistance, current rate of flow, and difference of potential; comparison of electric and mechanic units; the magnetic field; the relations of lines of force to one another and to various mediums; current electro-magnetic effects and instruments; development of currents in a closed conductor by changed relation of the conductor to constant or variable numbers of lines of force; application of principle to instruments; phenomena of currents in rarefied gases.

Chemistry. Physical and chemical changes; elements and compounds; nature of gases and their specific gravity; Avogadro's law and deductions from the same; weights of molecules and the analysis of compounds containing a given element with a view to determining the weight of the indivisible portion or atom of that element; the method of determining, and meaning of chemical formulas; the analysis of air and water and compounds of the elements of air and water; the principle of affinity as illustrated

by the processes of oxidation and reduction; atomicity and the chemical equation; a detailed informational study of well known elements and compounds with distinctions and nomenclature.

How much of the course outlined can be presented in a high school? That all depends upon the time allotted, but I would say all of the above topics would be presented in any fairly liberal time allotment.

It must be borne in mind that any course that does not hold a student rigidly to a perfectly definite line of propositions must fall short of the best results.

Something of consequence should be presented but, whether the amount be much or little, a firm mastery of that must be attained.

First books in physics are made valuable by heavy type headlines that fix and hold attention to fundamental ideas.

I valued very much the suggestion which Prof. Josiah P. Cooke of Harvard used to offer concerning laboratory books in chemistry when he said, "Use flaming headlines to express your idea of the importance of the results you secure."

It is desirable that a textbook should be small, not too wordy, and the explanation by the teacher should be brief except in the abundance of illustrations.

The points made should stand out prominently. Clear, strong statements in the best possible English count most, and their mastery by the students should be proved by close questioning that would show beyond a doubt that the principle was understood.

Having been mastered, its staying qualities should be tried at intervals by review problems to which the principle is applicable. Teachers need constantly to be on guard when presenting work to students lest they mistake their own enthusiasm and proficiency for that of the students.

I have heard college specialists say that they would prefer to have students do the beginning work in the various branches of science in the college. Beginning work must be done somewhere.

Why may this not be done splendidly in secondary schools by well trained teachers who possess knowledge, enthusiasm, and common sense?

Those whose work ends in the high school should have an opportunity to study physical science, and others who are preparing for college may be so well trained that the college instructors will be aided by the thorough fundamental preparation.

Probably it is not training elsewhere that is objectionable but insufficient training.

I believe that one can not attach too much importance to the use of cross-section drawings as a means of bringing out clear thought.

Good English speech and the power to illustrate and construct must ever be to the world satisfactory evidence of acquired power.

Finally, to be able to distinguish between essentials and non-essentials and to rate everything at its proper value is a high art everywhere recognized as a sign that its possessor is an individual of force and usefulness.

In this discussion I have made only a simple plea for the best possible training of youth that they may be able to understand a science of wonderful beauty and meaning to all who have dreamed of the something that underlies all reality.

Section B. BIOLOGY

CORRELATION OF BIOLOGIC SCIENCE WITH DRAWING AND ENGLISH IN THE HIGH SCHOOL

BY C. STUART GAGER PH.D., NEW YORK STATE NORMAL COLLEGE, ALBANY

It will make our discussion much more definite to define clearly at the outset the limits of the subject. By biologic science we mean the work in botany and zoology in the high school. Concerning the correlation of nature study with other subjects in the grammar school we have heard much and discussed much. Text-books on nature study have been written on the basis of such correlation, and in looking them through one sometimes wonders whether the intention has been to give the pupil an appreciation of nature or of anthology, of flowers of the field or of flowers of literature. Our discussion does not include nature study. Correlation is accepted here and almost universally practised.

Not so however when we come to the question of the correlation of biologic science with other subjects in the high school. Is it practicable and desirable to correlate botany and zoology with the high school work in drawing? I do not say possible. The pupil may study a butterfly in zoology, make the required drawings which shall be accepted by his drawing teacher as an exercise in that class, and write a description of his specimen which shall be accepted as a theme by the teacher in composition. Thus briefly put the problem is easy. No scheme for harmonious relation of the work of different departments could be more simple or more clear.

But is this plan that I have just outlined correlation in the sense which that term should always carry in education? Before attempting to answer this question we should keep clearly in mind the fact that correlation means co-relation. That is, each study should receive help from its association with the other. The advantage must be mutual so far as the subjects are concerned, as well as helpful to the pupil. The work in one study should enable the pupil to read more meaning into the other.

Correlation should have regard above all things else for the main purpose of each subject. One writer[1] has recently said, "If attention to correlation means neglect of the first principles of art, then the sooner the fetish of correlation is thrown away the better." So may the teacher of English protest, and so may the teacher of biologic science.

What, then, is the purpose of art education in the high school? Negatively, it is not to make artists or even draftsmen. About 1885 the idea began to be emphasized that drawing should be taught, not for its own sake, but merely to furnish the pupil with a tool which he could use in other studies or pursuits. He should be taught drawing just as he was taught the alphabet, so that he could read, or mathematics, so that he could keep his own accounts. The introduction of the idea of utility, the commercial idea, was to be expected in America. It could truly have been

[1] Coburn, Frederick W. Art in Public School Education. School Journal. 1901. 62:353.

prophesied. Our mission as educators is to combat it, and place before the pupil a higher ideal than this. There is a limit beyond which it is not desirable for education to emphasize or reflect the tendencies of the national and social life of the time. So, also, should we emphasize the fact that art education and drawing are not synonymous. Drawing will form part of a well rounded course in art, but only a part. Mechanical perspective and the production of working drawings will be included but will not be all inclusive. The art idea also will dominate part of the work in drawing, as when the pupil will be told to draw a branch of witch-hazel in autumn, or to sketch a leafless tree in winter.

This is what the purpose of art education is not. What it is, is not so easily told. Perhaps I shall be less open to contradiction in the positive statement if I use the words of a teacher of art who says[1] that "the study of art has for its true function the cultivation of good taste." This purpose is quite different from the education of an artist. The artist's work has for its purpose the expression of an idea or emotion "in accordance with the unalterably established canons of beauty," and his training must develop his natural ability along this line, but in the high school the purpose should be to give power of appreciation versus power of execution.

The student in the high school will doubtless learn something of how to draw and paint, and may possibly acquire some skill in doing both, but the chief aim should not be to train artists. The course will have accomplished its highest purpose if it has enabled the teacher to discover the born artist or draftsman, or if it has done what is still more important, namely, enabled him to discover himself.

And how shall we state the case for biologic science? Here also the aim is not to give technical training, or to produce specialists. There is a higher purpose than this, namely, to enable the pupil to come to himself. The course, it is true, should give him a foundation for more advanced biologic work, should he ever

[1]Coburn. *l. c.*

wish to pursue it. It should also help him to interpret his environment, and conform to it, and give him an appreciation of living things, but I believe that the fact needs special emphasis now that the function of the high school in all its courses is something more than technical training and preparation for college. It is preparation for life. If three or four years of college shall form part of the pupil's life he should find himself prepared for it by his high school course, but if college should be eliminated he should not feel that his preparation is any less adequate.

All of this may seem a long way round to correlation, and yet I believe that the intelligent discussion of the question demands a recognition of the truth of what I have said. As teachers of biology we must not let our own needs blind us to the rights of other subjects, or demand from them concessions calculated to defeat their highest functions in the curriculum. Lack of ability on the part of our pupils to record their observations by accurate drawings does not lead logically to the conclusion that the teacher of art should give instruction in the drawing of microtome sections as seen under the microscope. Neither does it follow that drawings acceptable to us would necessarily satisfy any requirements of the art course.

In how far may biologic science and drawing be so related as to be mutually helpful in the attainment of the main purpose of each course as stated above? I shall, perhaps, not voice the opinion of the majority when I answer, only to a very slight degree. The points of view in the two subjects are as diverse as north and south. One is analytic, the other synthetic. Their point of contact is the art of drawing, but the sole purpose of the drawing in biologic science is to record a fact, in art it is to express an idea or feeling or impression. The object of the artist is to express himself, but if there is any one thing that the scientist must eliminate from his drawings it is self, specially his emotional self. It is his business to express nature.

Contrast, if you please, the artist's representation of the head of a dandelion or of a golden-rod with that of the botanist. Of

what value would the former be in a laboratory notebook? Of what earthly use would the latter be in an art gallery? The artist draws a leaf to show the kiss of autumn and the warmth of Indian summer. The high school course should enable the pupil to appreciate this, and should disclose to him any natural ability he may possess so to draw a leaf as to convey this message to another. The botanist draws the same leaf to show a serrate margin, palisade parenchyma, and pinnate venation. The two purposes are mutually exclusive, and the drawing is of value in one subject just in proportion as it is lacking in the qualities that make it of real worth in the other. The purpose of the scientist is analysis, that of the artist synthesis. Dissection is the death alike of art and of nature study, but it is the very breath of life of biology.

I have not forgotten that Ruskin has said that, "The greatest thing a human soul ever does in this world is to see something and tell what it saw in a plain way." And Ruskin was speaking of art. To be true to nature he tells us is what the artist should strive for. But the correct interpretation of this principle is not as easy as its enunciation.

John C. Van Dyke says,[1]

You may be possessed of the idea that the object of a painting is to see how closely the artist can imitate nature—many people have such an idea. I beg of you to discard that likewise. Imitation never made anything worth looking at the second time. The world is indebted to it for nothing. The imitators have all died, like "poor Poll," without leaving a trace of anything we appreciate or care for. Their labor has been too ignoble and purely mechanical to endure. The painter detailing nature upon canvas line upon line, with no hope, object, or ambition but that of rendering nature as she is, is but unsuccessfully rivaling the photograph camera. The sculptor working in a similar fashion is but emulating the hideousness of the wax figure. No; the object of painting is not to deceive, and make one think he stands in the presence of real life. Art is not the delineating of peanuts and postage stamps in such a realistic manner that you stretch out your hand to pick them up; nor the molding of bronze and marble so that you start with surprise when you find that they are

[1] Van Dyke, John C. How to Judge a Picture, ch. 9.

not living. True, painting and sculpture are classed among the imitative arts, and so is poetry; but consider how far removed from reality is poetic language, and consider how wide the gulf between nature and the greatest masterpieces of painting. The idea of imitation is a false conception of art throughout. Painting is a language, and trees, sky, air, water, men, cities, streets, buildings, are but the symbols of ideas which play their part in the conception.

And further on we read,

A familiar scene—of valley, lake, mountain, or brookside—is chosen, and painted as it is, with lack of thought and want of feeling, painted simply that you may have a facsimile of what you possibly may not possess in reality. Such pictures are good reminders of the places we have visited, like the photographs we buy along the line of travel, and they may not improperly serve to conceal a break in the wall paper of the drawing-room; but they scarcely add to the world of art.

The artist must discover hidden beauty and reveal it to the world—the scientist must discover facts of structure and make them clear as day. Are the flowers of the forget-me-not sympetalous or polypetalous? What would the botanist not give to know, and what annoyance would it not cause the artist to have his attention distracted by the problem! "Paint the soul," says Browning, "never mind the arms and legs." Paint the arms and legs, says science, with all the bones and tissues and cells, and never mind the soul. The highest purpose that can be served by a drawing in science is to record a fact, that which was actually seen, but the purpose of the artist is to express the emotion occasioned in his own breast by what he saw. "Give us no more of body than shows soul," says Fra Lippo Lippi.

These two irreconcilable ideas not only dominate, the one art, and the other science, but should dominate the teaching of these subjects in the high school. How, then, may they be correlated? It is true that the artist must be able to see accurately and to tell the truth in his drawing. But that which he sees is beyond the ken of the scientist, as scientist, and he must not tell too much of the truth lest he descend to mere imitation. To use Browning's term, he must tell the truth "obliquely," which

Professor Corson[1] interprets to mean "inducing a right attitude toward, a full and free sympathy with the True, which is a far more important and effective way of speaking truth than delivering truth in re."

"Why do you paint the tree," asked the ignorant peasant of Millet, "isn't it there where any one may see it who wishes?" But the tree which Millet painted never existed till Millet created it. The model, it is true, was definite and particular in time and place and outline, but the painting of the artist is universal in every sense because it conveys a universal sentiment or emotion. This is why,

> "we love
> First when we see them painted, things we have passed
> Perhaps a hundred times nor cared to see;
> And so they are better, painted—better to us,
> Which is the same thing. Art was given for that."[2]

The pupil in the laboratory makes a drawing of a horse-chestnut twig, chiefly in order that he may observe it more accurately—incidentally in order to record his observation. I can see no reason why, after the science instructor has given his sanction to it, so far as botany is concerned, the drawing should not be accepted by the art teacher to stand the test of his criticism in partial fulfilment of the drawing requirements in the art course. But if the art course is dominated by the spirit and purpose of art and has not degenerated into merely a "class in drawing" there will not be many such opportunities. Just as forcibly might one argue that the teacher of biologic science should accept drawings made in the art room in lieu of additional laboratory study. And if we consider the other phase of the so called "drawing work," namely mechanic perspective and drafting, there seems to be even less opportunity to utilize the drawings made in one class in partial fulfilment of the requirements in another.

Every teacher of botany or zoology has realized that ability as an artist may often be a hindrance rather than a help in the

[1] Corson. Introduction to Browning. Bost. 1899. ed. 3, p.56.
[2] Browning. Fra Lippo Lippi.

laboratory. Here for every line in his drawings the pupil must be able to point to an element of structure in the object, but the art drawing must show light and shade and texture. How the pupil annoys us who persists in concealing structure by his profusion of shading! In the laboratory the pupil should confine his illustrations to simple line drawings. He may take his laboratory drawing of a fish into the art class and invest it with all the high lights and tone effects, and other accessories so dear to the artist. Its scientific value may possibly not be lessened thereby, but it is extremely doubtful if its worth as the record of an observation has been at all increased. Of course I am speaking now only of drawings made by high school pupils in actual laboratory work. What I have said does not apply to illustrations in textbooks.

And how shall the case be stated for English? Here again it is a case of community of purpose. If our subject read "biologic science and literature" we should be worse off than when we considered drawing, but the problem is less complicated when confined to English composition. Obviously the aim in the botany or zoology class is that the pupil shall describe what he sees in the clearest, most concise, and most vivid language that he can command.

If we let the aim in composition be stated by the rhetoricians, we shall read, "there is no higher attainment in literature, none which has given to its possessors more lasting fame, than the ability to make pen pictures—to so represent a scene in words that the reader becomes, for the time, an actual observer."[1]

Here we have agreement in purpose in composition and in biologic science. The high school work in composition should have as its chief aim to develop on the part of the pupil this ability clearly to express himself.

The first prerequisite for a writer is that he shall have something to say and a desire to say it. Without this a mastery of rhetoric and of the principles of composition are of little avail.

[1] Clark, J. Scott. Practical Rhetoric. N. Y. 1891. p.263.

And yet the possession of something to say is not the only requirement. Some time ago a writer in *The Critic* said

> The development of scientific method is alleged to be one of the foremost characteristics of the present century. Philologists will ransack the earth, if not the heavens, for exact information as to date and authorship of even the fragments of ancient literature; botanists will tramp the forests for months to verify or disprove the rumor of a new orchid, and astronomers will go to any accessible point on the face of the globe for more exact figures on an eclipse or a transit of Venus. We might, then, expect to find a corresponding effort for exactness in the expression of thought, but an examination of the evidence is not altogether encouraging.

In *Science* for Oct. 30, 1903, P. C. Warman gives the results of his attempts to prove this assertion. Having an intimate acquaintance with the manuscripts of about 100 contributors to scientific literature, he has classified these writers as good, fair, and poor. Good means "those whose writing is clear, orderly and forcible"; fair, "those whose writing is, indeed, clear and passably methodical, but is not forcible"; and poor, "those whose writing is turbid or chaotic or has other defects which render it of little value, such as extreme verbosity." 24% of the writers fall into the "poor" group, 57% are "fair," and only 19% can be classified as "good."

This certainly emphasizes the need among scientists of increased ability to express themselves well. Where shall this training be given? One could hardly argue that time for it should be taken from the biology work. It is a question, pure and simple, of the use of good English, and therefore is a problem to be solved in the class in composition and rhetoric. "Doubtless," as Mr Warman suggests, "the technical description of a dinosaur or of an aboriginal shell heap can derive little aid from metonymy or climax, but the field of the scientific specialist merges insensibly in common ground, and when he is on the borders he is in view of the whole field of letters." What, therefore, are the possibilities of correlation between biologic science and English? What can the language contribute to help the science, and what may the science contribute to help the language, to the end that

the burden of work may be lessened, its quality in both subjects improved, and the pupil ultimately benefited?

Compositions are classified under description, narration, exposition, argumentation, and versification. It is in one of these five formal classes of composition that we must find the opportunity for correlation. Surely we shall not find it in versification, neither in argumentation without forcing the matter. To be sure the pupil could write an argumentative paper to persuade another that the cotyledons of the castor oil seed are not plumules, or that the thorns of the honey locust are modified stipules. But I believe that any attempt at correlation here would be merely for the sake of correlating, or forcing a point.

Exposition is "the statement or discussion of an abstract or general theme."[1] Obviously there is little opportunity here for correlation. Of course all these remarks refer to high school work, and high school pupils. A Darwin or a Huxley may indulge freely in argumentation and exposition, but in the high school instruction in biologic science these forms of discourse would scarcely enter at all.

If the science class takes the much advised but little practised field excursions then there is an excellent chance for a narrative theme describing the trip. The teacher of composition ought to be grateful to the science teacher for furnishing a theme outside of the encyclopedia, and the science work will profit by the criticisms of the master in English. Here is a most excellent opportunity for correlation, for the work in both subjects will be greatly benefited thereby. Yet we are hardly justified in asking the language teacher to accept accounts of field excursions in biology in fulfilment of all the requirements on narration.

We have finally to consider description. What would the science teacher in high school or in college not give if his pupils could only describe in words what they see! Lack of ability to draw is chiefly lack of ability to see, but lack of ability to use the queen's English is due to something else besides want of power to observe. Here, indeed, can the work in biologic science

[1] Clark, J. Scott. Practical Rhetoric. N. Y. 1891. p. 283; *also* Standard *Dictionary*.

profit by the work in English, but this does not necessitate correlation. General training in description will help the pupil when he comes to describe a starfish or a flower. The first requisite in the laboratory is that he shall observe the thing, and the prime test of the description is that it conveys to the reader in concise language an accurate, clear, and definite idea of the thing observed. Compare with this the first requisite as stated by Clark.[1] "The reader should gain a perfectly clear and permanent idea of the general shape of the object described." And so he proceeds to enumerate the criteria of a good description, in nearly every one of which the high school teacher of science bemoans the weakness of his pupils.

But after all has been said, I must affirm, even at the risk of being accused of arguing the case for the teacher of English, that, so far as correlation between biologic science and English is concerned, the limitations exceed the opportunities. Composition is par excellence a literary study. To make it merely ancillary to science is to defeat its highest aims. The pupil must be equipped to appreciate and distinguish the good from the bad in literature, as well as acquire ability to express himself well. Not many descriptive themes can be written in one year, and only a small per cent of these can come from the science work without weakening the course in composition.

The special problem we have been discussing is only one phase of a broader one. It involves the whole question of the possibility and desirability of correlation in the high school. On the whole I believe the plan which gives such admirable results in the grammar grades is neither feasible nor desirable in the high school. Younger pupils are not specialists. They are generalists. The treatment of the various subjects in the grammar grades is not intensive, but extensive. Lines of demarcation are not closely drawn. If you shut one eye nature study looks like biology, if you close the other it is literature and art, while if you look at it with both eyes open it becomes so broad that one writer may correctly define it as "seeing the things that are worth seeing, and doing the things that are worth doing," while

[1]Clark, J. Scott. Practical Rhetoric, N. Y. 1891, p. 263.

by another enthusiast it is vaguely described as "a point of view." Surely there is nothing intensive here. A similar statement of the case may be made for geography, and number, and language. Not so, however, in the high school. All truth is one, to be sure, and the different knowledges are merely different views of truth. All the subjects of the high school course are related and interdependent. Computation belongs to both mathematics and physics, specific gravity to physics and chemistry, osmosis to physics and chemistry and the biologic sciences. All of these subjects must be expressed in language, and the verbal statement of them assisted by illustrations. It does not logically follow, however, that the curriculum must, or even can be, laid out on the basis of correlation. The treatment of each subject is intensive, and although in their broadest aspects all of the formal subdivisions of knowledge overlap, the exigencies of high school work make correlation impracticable. An attempt to force it to any great degree would only serve to introduce confusion and lack of definition. The best place for different subjects in the school course is a question on which there is yet a great diversity of opinion, and the program is quite likely not to favor correlation, for the principals, and not the teachers make the programs. Composition and drawing, for example, are quite likely to come in the first year of the course, while the chances are that the biologic sciences will come later. This alone is an obstacle to correlation.

In conclusion then there are three facts that render the correlation of biologic science with drawing and English, and correlation in general in the high school either impracticable or undesirable. First, lack of community of purpose in the various subjects; second, change from an extensive study in the grammar grades to an intensive study in the high school; third, lack of agreement in the time when the studies are pursued.

I fear I have not made out a very strong case on the positive side of my subject. The strength of the negative side, as I see it, is determined beforehand, and I can only hope that these words have given it clear expression and carried conviction to my hearers.

Harriette Arms Curtiss—In opening the discussion on the correlation of biology with English and drawing I wish to present four controversial points.

1 Knowledge is a unit. Students have been dividing it into fractions since the first attempts were made to classify. Halves, the so called trivium and quadrivium were introduced by the ancients and specialists have been developing the numerous departments of the modern curriculum ever since. It is as if a large open sunlit space had been divided by partitions into private apartments. Eact partition shades the area it incloses from a portion of the sunlight of truth. Mr Dewey has shown that all divisions among subjects are arbitrary and artificial.

Science teachers are beginning to tear down the partitions on the sides of English and drawing, two excellent points of attack but far from exhausting all possibilities. The resulting correlation so called is one of the most important tendencies in the science of education of today. Possibly the next generation will credit biology teachers with its initiation. It must be remembered however that one person or group of persons can not correlate, the word means to have mutual or reciprocal relations. Our friends the English and drawing specialists must come halfway in order to bring the subjects together satisfactorily.

2 One written page corrected by the biology teacher for English and subject-matter is of more value to the student than 10 pages that could be corrected in the same length of time for bald facts that in other connections are sometimes called gradgrind. Require as much written work as you like from students, correct as much as you are physically capable of doing, or a little less, for grammar and subject-matter, let the rest go and do not worry about it. Do not correct anything for the scientific facts simply. Accuracy is biology's first law.

3 Require a little written work for each subject studied. This may be notebook work, examinations, the written answers to two or three leading questions dictated one day to be prepared for the next or often one sentence or one paragraph written in five minutes of a recitation period on some subject, say "Physiologi-

cal Division of Labor." The nomenclature of science, when reduced as much as possible is so difficult that students can not master it with only oral use. In a physiology class of 26 members last month I developed the "mechanism of respiration" as thoroughly as possible. In an incidental test one excellent student wrote an excellent paragraph on the "Methodism of Respiration." I had never previously considered it a denominational process.

4 The correlation of biology and English means more than mere data plus grammar and rhetoric. Why not use Holmes's *Chambered Nautilus* when studying Cephalopoda tetrabranchiata, and Burns's poems *To a Mouse* and *To a Mountain Daisy* in appropriate connections? When teaching the circulation of the blood this passage from *Julius Caesar* may be introduced.

> You are my true and honorable wife,
> As dear to me as are the ruddy drops,
> That visit my sad heart.

The facts that Shakspere wrote *Julius Caesar* before 1610 and that Harvey discovered the circulation of the blood in 1616, the year of Shakspere's death, announced it in 1619 and published it in 1625 will impress any class with the marvel of Shakspere's genius as much as any English teacher could.

Have I proved these points?

Prof. J. E. Kirkwood—I agree in many points with Dr Gager but it occurs to me that where the biologic side of botany and zoology, or, if you choose, the ecologic side, is emphasized, fewer obstacles are presented to the proper correlation of these subjects with art and with English. In this connection we might point to the work of William Hamilton Gibson as exemplifying the possibilities in this direction. Gibson was preeminently an artist both in language and pictorial work, though dealing very often with commonplace things, and still is conceded to have been accurate as a naturalist. So it would seem to me that the performance of accurate work in biology need not by any means be divorced from the exercise of the artistic sense or the use of beautiful or eloquent language.

CORRELATION OF BIOLOGY WITH SANITARY SCIENCE

BY PROF. JAMES H. STOLLER, UNION COLLEGE, SCHENECTADY

The last 25 years have marked great progress in hygiene, using this term in the meaning given by Professor Sedgwick, as "the whole science and art of the conservation and promotion of health, both in individuals and communities." By a series of brilliant discoveries, essentially biologic in their nature, though the researches which led to them were made chiefly from the standpoint of medical science, a revolution has been effected in our attitude toward the causes and the means of prevention of many diseases. We know now that at least one half of the diseases to which the human body is subject are due to the entrance of organisms into the body, and their interference with its normal workings. To keep well means, to a large extent, the same thing as to keep these organisms out of the body, or to maintain the body in such a condition of vigor as to resist their attacks. It is now recognized that the health of communities depends to a large extent on the effectiveness of measures taken to prevent the incursion and spread of micro-organisms, producing diseases. State, municipal and other boards of health, organized to safeguard the public health, find their chief field of activity in putting into operation the means available for excluding and controlling infections, in other words, the specific organisms causing communicable diseases.

The question we wish to consider is whether the teacher of biology is to take into account this body of new knowledge regarding the biologic aspects of disease and its applications in sanitary science. Does it properly fall within the scope of his work to present it and, if so, how best can this be done?

As to the need of the education of the general public in matters of sanitary science there can be but one opinion. Professor Sedgwick, in his book, *Principles of Sanitary Science and the Public Health,* says: "With the single exception of the changes effected by the acceptance of the theory of organic evolution, there has probably been no modification of human opinion

within the 19th century more wonderful, or more profoundly affecting the general conduct of human life, than in our attitude toward the nature, causation and the prevention of disease." Now the attitude here referred to is that of the sanitarian and of the medical profession. But the full benefit of the new knowledge will not be realized till the general public also shares in this attitude. The public will support and cooperate with health authorities according as it understands the principles and methods of sanitary science. It is still true that in many communities, specially the smaller villages and the rural districts, little attention is given to caring for the public health. There is still a vast amount of human suffering and loss of life that could readily be prevented if people were educated up to the point of appreciating the need of a vigorous supervision of matters pertaining to the public health. The day of epidemics of sickness has passed, or ought to have passed. When disease goes stalking through any community today it has back of it ignorance or carelessness which is a disgrace because it is unnecessary.

Should not the schools, then, have a larger share in this educational work? What kind of ignorance is it more worth while to dispel than that which is the cause of physical suffering and loss of human life?

Already instruction in hygiene is given in the schools. In connection with physiology there is usually taught the hygiene of food, clothing, exercise, rest, bathing, ventilation, the care of the teeth, eyes, etc. Our plea is for a more extended and comprehensive hygiene, including more of the facts about the nature and causes of sicknesses and of the methods of modern sanitary science in preventing sickness.

No new course of study is called for in order to give instruction in these matters. The work can be correlated with the usual courses in botany and zoology. The most direct connection is afforded in the treatment of these sciences from the systematic standpoint, or that of classification of plants and animals. Bacteria may be taken up for study as constituting one of the groups of plants. Even when the course in botany deals chiefly

with the flowering plants, the teacher can readily give, as a brief supplementary course, some account of the simplest plants belonging to the microscopic world, and including the bacteria. In what is here said it is assumed that the teacher will have at hand a compound microscope and the few materials necessary for making some cultures of bacteria. We shall suggest presently a number of simple experiments and demonstrations that can be made.

In a course of zoology, a connection for presenting the data of sanitary science is afforded in the study of the protozoa. The amoeboid parasites, causing malaria, yellow fever and, according to a recent announcement, smallpox, may be considered in connection with the study of amoeba. The pathogenic bacteria may be referred to and their role in relation to disease may be discussed in connection with the bacteria that appear in the hay infusion employed to demonstrate infusoria. The integrity of a course either in botany or zoology need not be destroyed in order to include in it the study of the microorganisms, a knowledge of which bears so direct a relationship to human welfare. They are organisms, and it is as legitimate to study these in a course in biology as any other organisms.

But before going farther we wish to say, and with emphasis, that there should be no note of the alarmist, no touch of the sensational, in treating of the pathogenic organisms. The first thing to be said of bacteria is that as a group of plant organisms, numbering thousands of species, they play a useful part in nature and are beneficent toward man. But just as among the larger plants, while the vast majority are useful to man, supplying him with food etc., there are a few that are poisonous; so among these minutest plants, there are a few that are harmful to man, causing, under certain conditions, disease. At the right time it should be explained, too, that nature has provided safeguards against the evil powers of these bacteria; that, ordinarily, if the body is in a condition of health it has power to withstand the incursions of disease germs. The vast majority of bacteria that we take into our bodies, along with our food and drink, are

destroyed by the action of the digestive processes in the stomach. It should be explained, further, that even where bacteria get into the tissues or the blood it has been shown in certain cases that the leucocytes, or white cells of the blood, devour and digest the intruders. In this connection, too, mention should be made of the wonderful power which the body has of producing within itself neutralizing substances, or antitoxins, which destroy the effects of the poisonous matters given off by the bacteria.

Of course these and all other generalizations should be presented, as far as possible, in connection with demonstrations, or at least in connection with a statement of some of the concrete facts upon which the inductions are based. Some simple demonstrations and experiments which will serve to make the work real to teacher and pupil and keep it in line with the methods of the courses in botany or zoology are here suggested:

1 A microscopic examination may be made of the material which accumulates in the mouth at the junction of the teeth and gums. It may readily be obtained by gently scraping with the blade of a penknife on the side of the lower incisor teeth. Along with the tartar, loose epithelial cells and mucus, will be found an abundance of bacteria representing (if I may judge from the exhibit obtained from my own mouth) several morphologic types, including spirillum. As an interesting historical note it may be mentioned, in connection with this demonstration, that the first descriptions and drawings of bacteria, made by Leeuwenhoeck, the father of microscopy, in 1683, were from material taken from the teeth.

The teacher may explain why the cavity of the mouth affords a favorable lodging place for bacteria. Its walls are moist and of an even warm temperature; the mucus and bits of food remaining in the mouth, specially if one is careless in the matter of cleansing the mouth and teeth, afford abundant nourishment for the bacteria. The mouth is in fact a favorable incubating chamber and bacteria rapidly grow and multiply there.

The pupils will wish to know whether these bacteria are harmful, and, of course, can be assured that they are not. Still it is

wholesome to keep the mouth as free from them as possible—they undoubtedly cause a bad taste in the mouth—and it is as well to brush the teeth not only every morning but also every night on going to bed. It should be borne in mind, too, that bacteria have a part in causing the decay of teeth, and this is another reason for keeping the mouth free of them, as far as possible.

The teacher should then explain that certain disease-producing bacteria may find entrance to the mouth and cause disease. Thus diphtheria is always due to a specific bacillus localized in the throat, and finding its way there, apparently, through the mouth. Hence the danger of infection from the breath of persons suffering from this disease. How important then that diphtheria patients should be quarantined and that plenty of time should be given for convalescence before they associate again with their schoolfellows.

A brief explanation of present methods of diagnosing and treating the disease of diphtheria may then be given. The teacher will not of course go into technicalities and will avoid the appearance of assuming any special or professional knowledge. But the pupils can be told why the physician obtains a portion of the white membrane from the throat of the patient and how, if the bacillus of diphtheria is found to be present, an antitoxin remedy is administered. A statement may be made as to the great saving of human life, as shown by statistics collected by health boards, in regard to the number of deaths due to diphtheria since and before the discovery and use of antitoxins. Thus in New York State the mortality from diphtheria from 1888 to 1895 was 50.19 per 1000 deaths from all causes, while from 1895 to 1901 the rate was reduced to 29.57.

2 A demonstration of the presence of bacteria in the air may be made by the use of the ordinary gelatin plate cultures. The teacher may then explain that while ordinary air bacteria are harmless, yet it has been shown that certain disease germs are carried by currents of air. Experiments, similar to the one just made, of exposing culture mediums to the air of hospitals where

there were patients suffering from consumption of the lungs, or some other form of tuberculosis disease, have shown that the specific bacteria causing this disease are capable of being distributed through the air.

3 A slide demonstration of the bacillus of tuberculosis may then be made. Through a physician sputum from a tuberculous patient may be obtained and a mount prepared. This involves the staining of the bacilli, but this is not specially difficult. A slide prepared by the teacher affords a much more effective demonstration than the use of a ready-made slide obtained from a dealer, though the latter may be employed where the difficulties of making a slide seem too great.

It should then be pointed out that the wide prevalence of the disease, causing as it does 10% of the deaths that take place each year in the State of New York, is due, to a large extent, to the distribution of bacilli derived from the sputum of persons having the disease. The bacilli are not killed by the drying up of the ejected sputum, but in the dry state or in the form of spores remain alive a long time and are readily caught up and distributed by currents of air. Thousands of people die every year through inhaling particles of dried sputum in which the living tubercle bacilli are present. How important then that the ejections from the lungs of tuberculous patients should be destroyed by burning. The point should be enforced that tuberculosis, while now a disease the most destructive of human life, is yet one which to a large extent is preventable and that it is possible that, if the means of preventing it now known to science were everywhere put into practice, the disease would eventually be exterminated.

4 The presence of bacteria on the skin of the hands can readily and prettily be demonstrated by the use of potato cultures. Two slices of sterilized potato are placed in glass dishes with covers. Just before putting on the covers the finger is rubbed over one of the pieces. In a few days a luxuriant growth of bacteria will have formed where the finger was in contact with the potato.

This serves to show how diseases may be communicated by contagion, in the sense of contact. It should be explained that in all eruptive diseases, as measles, scarlet fever and smallpox, the disease germs exude from the pustules or inflamed blotches of the skin and so can be transferred to another person through touch or be transported on clothing. The importance of quarantine may then again be pointed out and attention drawn to the fact that under present day quarantine methods the diseases just mentioned are held in check, no longer running through whole communities as scourges, or plagues, as was the case in former times. Mention may be made, too, of the importance of disinfection, and some account may be given of the ordinary disinfecting agents.

5 The attention of the pupils may be called to the fact that when the skin of fruits, like apples and grapes, is broken putrefaction sets in. This putrefaction is due to yeasts and bacteria of the harmless kind, so far as man is concerned. But just as the skin of fruits serves to protect the juicy pulp from the invasion of outside germs harmful to them, so the skin of our bodies protects us from the entrance into the blood and tissues of certain harmful bacteria. When the skin is cut or broken by a bruise, bacteria are almost sure to find admission. Most of these cause only inflammation of the wound, but there are a few kinds that produce more serious effects. One of these is that causing the disease of tetanus or lockjaw. This germ lives in soils and hence the danger of getting dirt into wounds. Many cases of lockjaw, not a few of them proving fatal, are occasioned every year by the use of the toy pistol. Happily an antitoxin remedy for tetanus is now known, and last year the authorities of the New York State Board of Health made ready a large supply to meet the special demand in connection with Fourth of July casualties.

6 An interesting and instructive laboratory experiment was described in *School Science* of April of this year, and reprinted in the July number of the *Journal of Applied Microscopy*. The work was done in a secondary school laboratory and had as its

object "to determine experimentally the part flies may play in the transmission of bacteria." The apparatus consisted of a box divided into two compartments, in one of which food material infected with a pigment-producing bacterium was placed. As soon as flies were seen to eat of the food or walk over it they were allowed to pass into the second compartment, in which was a glass dish containing a culture medium. Agar-agar was used in the experiment, though gelatin or even potato would answer equally as well. It was found that in a few days the tracks of the flies were marked by colonies of bacteria showing the characteristic pigment color of the species with which the food was inoculated. The experiment was repeated with various modifications. Flies were caught with sterile forceps, washed in liquefied agar-agar, which was then poured into sterile dishes and allowed to solidify. All of the dishes developed colonies, and the conclusion was reached that "flies in nature probably always do carry bacteria with them," and that "it is probable that they can and do carry the germs of any disease that offers them an opportunity to come in contact with infected matter."

A practical lesson to be drawn from these experiments is that the excreta of typhoid fever patients should be disposed of in a way to prevent the possibility of flies and other insects acting as the carriers of the germs of this disease.

The subject of insects in relation to disease being thus brought forward, the teacher may give some account of the part certain species of mosquitos play in causing diseases of malaria and yellow fever. The files of the scientific journals, as well as the book by L. O. Howard, the government entomologist, afford information on this topic. Care should be taken to explain that the malaria causing mosquitos are not the common species, but particular species which breed in swamps and stagnant waters. The means of preventing malaria are, therefore, the drainage of swampy grounds and the filling up of stagnant pools and ditches.

7 A disease concerning the nature of which, its causes and the means for its prevention, the public stands greatly in need of enlightenment is that of typhoid fever. It may be taken as

thoroughly established that the usual cause of this disease is the drinking of impure water. This statement may be narrowed and made more explicit by saying that the usual cause of typhoid fever is the drinking of water that has sewage in any form or quantity mixed with it. Any stream, well, or spring which is open to access of excreta, directly or indirectly, may contain the infection of typhoid fever.

An experiment which affords a good basis on which to give instruction in regard to this disease is the simple one of making two gelatin plate cultures, one of water known to be uncontaminated, as that of a country spring, or the filtered water of a city water plant; the other of water from a sewage-polluted stream, as any river on whose banks cities are located. The contrast in respect to the number and varieties of the colonies developing will be very marked. The teacher may then explain that water is the natural home of many kinds of bacteria; that just as all ordinary streams and ponds contain various forms of animal and plant life, so likewise bacteria and many other microscopic organisms live in water. In general these do no harm to man; it is probable that unpolluted natural waters, like the mountain streams which are the head waters of rivers, are quite fit for human use. But just as soon as natural waters are rendered unnatural, that is just as soon as pollution in the form of wastes from factories located on their banks, or, worst of all, sewage discharged into them from cities or villages, or even single houses, situated on their banks, they become dangerous for use for drinking. It has been found out that certain bacteria are capable of living in two phases of existence. In one of these phases they are parasites living in the alimentary canal and in certain other organs of the human body and causing disease. In the other phase of their existence they live in water. Typhoid fever is one of the diseases which are due to bacteria which exhibit this dual mode of life. They are always present in the discharges from the intestines of persons sick with the disease; the discharges being sewered into streams, the bacteria then enter upon the alternating saprophytic phase of their life history. They

are capable of living in water a long time. The evidences are that they are constantly present in sewage-polluted waters. If such waters are used for drinking the bacteria may again pass into the parasitic stage, causing the disease of typhoid fever.

The lesson is that the only waters that are fit to drink are natural waters from sources where access of human wastes is impossible, or waters from which impurities have been removed by the means devised by sanitary engineers, such as filtration-plants. Most of our cities have provided themselves with pure water supplies; it is rather in smaller communities, where there is no system of disposal of sewage, and where well waters, located near vaults, are used for drinking, that this disease breaks out. Sometimes it takes on the form of an epidemic; in every recent instance of epidemic typhoid fever the cause has been found to be an impure water supply.

What has now been said is enough, it is believed, to indicate the method by which instruction in sanitary science, in its recent important developments, can be given in connection with the courses in biology in the secondary schools. Of course there are difficulties to be overcome—lack of equipment, pressure of other work, etc.—but they are only the difficulties which always have to be overcome when a new line of work is taken up, and science teachers have achieved too many victories to doubt that success will await upon any new efforts.

Dr Frederick W. Smith Biologic research is doubtless largely responsible for our modern scientific attainments pertaining to hygiene and sanitation as well as much of our recent progress in preventive medicine. It is but natural or reasonable that the study of the structure, development, and function of life should teach us something regarding the preservation of life.

To what extent should sanitary science be the subject of instruction

There is certainly great need for a more general knowledge in matters pertaining to hygiene. The practical application of hygienic measures or the satisfactory enforcement of sanitary laws can not be successfully accomplished in advance of public

opinion. Public opinion is largely the exponent of public knowledge. The first duty then of the sanitarian is to instruct the public. Public instruction must be primarily through the medium of the institutions of learning. Up to the present time instruction in sanitary matters has been largely through the medium of physicians, medical journals and sanitary societies. The general public has yet little knowledge or appreciation of sanitary or hygienic requirements. It has been and is still most difficult to secure proper legislative enactment on sanitary matters. Legislators and those in authority still seem to consider sanitarians visionary doctrinaires and their recommendations as impractical fads unworthy their serious consideration and thus it is plain that it is not alone the poor and ignorant that are in need of sanitary training or instruction.

The extent to which advanced sanitary science should be taught depends on circumstances or rather the capacity or positions of the student or the position he or she is to occupy in life. Thus I believe the fundamental principles of hygiene and elementary physiology should form a part of elementary education. In the high school some instruction should be given in chemistry, bacteriology, personal house hygiene and general sanitation; in the university advanced bacteriology, chemistry, chemistry of foods and general sanitation. Instruction in hygiene should be begun in the kindergarten, and continued through all the higher courses of study.

Teaching of hygiene and granting of diploma of doctor in public health

There has recently been considerable agitation of the matter of the teaching of hygiene and granting of diploma of doctor of public health. I am not quite satisfied as to the practicability of this measure. To cover the entire field of sanitary work requires a very wide range of study, in fact, so large is the field and so complex are the various problems involved that it seems necessary to specialize in the higher education and practical treatment of the various departments of sanitary science. Then

in the organization for sanitary work are we not likely to proceed with more advantage and with better prospects for success and advancement by specializing in the different lines of work? Specializing certainly favors concentration of thought, individual research, and progress, and thus contra indicates the attempt to combine all knowledge or its practical application in one individual. The work of a health officer of a city makes it necessary that he should be a physician that he may diagnose and differentiate the various infectious diseases. The health department also requires the services of a competent chemist for the analysis of water, drugs, milk and other foods but he need not be a physician. Every city needs the services of a competent, practical bacteriologist but he need not be a chemist for he will find all the work he can do in his own department. The health department needs the services of a veterinarian to look after infectious diseases in domestic animals, examine cattle furnishing the milk supply, the sanitary condition of dairy stables, the food and water supply of cattle, the inspection of abattoirs, butcher shops etc. Sanitary inspectors are required who, while they do not need the technical knowledge of a physician, bacteriologist or chemist, must have special knowledge or training fitting them for their work. There are many sanitary problems in drainage, that require the services of an engineer. Every sanitarian or specialist in hygienic work must have a well grounded general knowledge of chemistry, bacteriology and general hygiene. Just how much of hygiene should be taught in the kindergarten, grammar school, high school, university, agricultural, veterinary or medical school I am not quite prepared to say but unquestionably a stated curriculum should be devised, authorized and required which should be applicable or adapted to the various grades of study, or positions students may be expected to fill in after life. Hygiene should certainly be taught in all institutions of learning for every individual needs a considerable knowledge of the principles of hygiene and general sanitation that he may be able to at least protect his own life under adverse sanitary conditions.

In connection with the course in architecture something in sanitary engineering should be required. The sanitary expert engineer must have the same general knowledge of chemistry and bacteriology that should be required of the medical health officer but he does not require the special instruction in preventive medicine and infectious diseases.

The first essential of well being or well doing at any period of life is good health. At the same time it is a fact that but few people enjoy perfect health, notwithstanding, that nearly all diseases are preventable. To cure disease and correct disease tendencies is the specific duty of the physician. To instruct healthy people how to keep well should be the duty of all teachers. It is obvious that in education rather than in compulsory legislation lie our most potent factors for preventing disease and maintaining good health. Still will intelligent people continue their indifference to hygienic laws and requirements and to violate the laws of nature and sacrifice health and even life itself for petty ambitions and greed for gain. For the protection of health and the prolongation of life, personal hygiene in its various phases is of no less importance than general sanitation. Personal hygiene is applicable to all individuals and to all positions or vocations of everyday life. The practical and comprehensive application of personal hygiene implies simply, correct living and right doing and is of quite as much importance to the moral, as to the physical side of life. While there have been great advances in the practical application of hygiene in recent times, I can see in the future still greater possibilities in its influence on posterity, in the prevention of degeneracy, crime, and unfavorable heredity as well as in the further prolongation of human life.

George H. Hudson—I believe that in many if not all schools the period devoted to physical exercise is one unthinkingly devoted to the spread of tuberculosis. A test of the air made during, or just after exercise, shows a very marked increase in the number of dust particles and bacteria. With the present percentage of cases, every class is likely to have one or more infected members, and till they are taught what it means to keep the clothing free from

the tubercle bacilli, they will most certainly add dust containing these bacilli to the air of the room. Large, well ventilated, and clean rooms, and special suits which could be hung in a small compartment and treated with steam once or twice a week, would cut the danger down to a minimum. The time is coming when the school, and after it the home, will delight in the cleanliness of a well regulated hospital, but the time may yet be far distant.

Section C. EARTH SCIENCE

HOME GEOGRAPHY. ITS PLACE AND PURPOSE IN GEOGRAPHY TEACHING

BY COMMISSIONER H. IRVING PRATT, OSWEGO COUNTY

There are several definitions of home geography. For this reason, it seems well at the outset to define it from my point of view. The study of the origin and development of one's physical environment and its relation to life is home geography.

The question, what constitutes one's physical environment naturally arises. The answer depends on who that one is, whether he be the child, youth or adult, for a person's environment has a greater meaning with his experience. The child sees the things in his immediate environment as far as they administer to his enjoyment, as the brook, valley, meadow, hill, pond, farm, store and mill. The youth sees all these and more, for he begins to see relations between his physical needs and the earth forces which wholly or in part supply his needs; also how those forces are modified by climate, erosion, etc. The adult perceives how the various sciences are related to the different industries, how the different industries and the various means of transportation and communication are related to commerce, and how commerce leads to a world-wide exchange of ideas as well as commodities.

The day has gone by when in our best schools we found geography taught on the old basis; when mechanic memory played such an important part. Many of you recall the time when the child learned "A body of land entirely surrounded by water is an island," without seeing the island; when the child learned to bound every town in the county and every county in the state as mere facts.

I inspected a school not long since where the teacher had a five year old girl name the northern, eastern, and southern tiers of counties of this state for my benefit. It was seemingly a prodigous feat, but what was the benefit to the child? Could not the girl's time have been spent to better advantage under proper teaching?

On its new basis, the life element is emphasized in geography work. Relations between life and earth are constantly shown. Professor Farnham says, "Any geography lesson is incomplete unless it has some phase of the life element in it. Relations should be shown between life and earth."

The place of home geography first of all, is found among the first lessons taught the child. Ritter says, "The very first step in a knowledge of geography is to know thoroughly the district where we live." Then, the first place of home geography is found in the study of that part of the earth's surface lying just at our doors.

Almost everywhere are the store, where something concerning trade may be learned, the mill from which the child may learn how the different grains are ground into flour, and the stream from which he may learn the uses of water. Almost at our doors are the hill, brook, pond, etc. The hill that the child climbs and coasts on, by an appeal to his imagination, may be made to represent some lofty peak. The brook that flows through his father's farm or the little stream formed by the sudden shower may speak to him of the Mississippi, or some other large river. Similarly the idea of sea or ocean may be deduced from that of pond or lake.

The child's great physical needs are already known to him. Many of them are supplied from his physical environment. Let us then consider them—need of food, need of clothing and need of shelter.

Every child eats three meals a day, not to mention between meals. One of the commonest of his foods is bread. By following bread through successive steps back to the soil, he learns many things. Some of which are as follows:

1 His parents possibly buy bread from the baker

2 The baker buys flour from the merchant and makes bread to sell

3 The merchant buys flour from the miller

4 The miller buys wheat from the farmer to grind into flour

5 The farmer grows the wheat in his field

In connection with the above, lessons of an elementary character can be taught about home industries. I have selected three common ones, farming, storekeeping and milling. Much valuable material of special interest to children can be found in studying these industries. What I shall give will be merely suggestive.

1 Farming

a The farmer raises cows, swine, sheep and other domestic animals, and grows grains and vegetables

b The farmer's needs are: food for himself and his animals; a house for himself and a place of shelter (barn) for his animals at night and during cold weather

c Growing of plants to feed himself and cattle

d The earth conditions which favor the growing of plants are, (1) gentle slope for drainage and ease of cultivation, (2) fine, moist, rich soil to supply food for plants and (3) sufficient light and heat from the sun

e The preparation of the soil for growing useful plants

f Sowing the seed and caring for the plants

g Cutting the hay and corn, harvesting the grains and gathering the fruits

h Taking the farm produce to market

2 Storekeeping

a Use: to sell what a person needs and buy the farmer's produce

b Kinds of goods bought at the store: sugar, flour, tea, coffee, clothes, etc.

c Money, eggs, butter, wood and work are paid for the goods

3 Milling

a Use: to grind different grains into flour

b The grinding is done by great rollers or stones

c Water is usually the power that turns the great wheel. Because of this, the mill is generally built on the bank of a stream

d Uses of water to different forms of life.

(1) Man: (*a*) turns the great water wheel; (*b*) place for fishing, bathing, boating and skating; (*c*) place where ice is procured

(2) Animal: (*a*) to drink; (*b*) for some, to bathe in; (*c*) for some, a home; (*d*) place to get food in or from

(3) Plant: (*a*) need it for life

In considering our next great physical need—need of clothing, we find several points of contact. Take for example clothing made from wool. While studying farming, take the raising of sheep; storekeeping, the buying of cloth or clothes and milling the making of wool into cloth.

The point of contact depends on the child's environment. If he lives in a farming community, the raising of sheep would be best; if in a milling district, the making of wool into cloth, and if in a business center, the buying of woolen cloth or clothes.

I shall select as the point of contact the raising of sheep, as I live in a farming section. The children know the sheep by sight. Many of them are familiar, to some degree, with its food, habits, characteristics, and uses to man. The teacher should take note and make use of these facts.

Though the different stages—washing and shearing the sheep, picking, greasing, carding and spinning the wool and weaving the threads—that the wool goes through to make cloth are not in the province of geography, they could be taught as lessons in nature study. Lessons on spinning and weaving wool by our grandmothers would be very interesting and instructive. The teacher, if possible, would have an old-fashioned spinning wheel at hand and take the children to see the loom used for weaving cloth years ago. The looms of this kind in use are not numerous, but the idea can be gotten from the carpet loom or from pictures of it. These observations of primitive apparatus are a good starting point to teach the wonderful advance made in the last 50 years in the machinery used in the manufacture of cloth.

In teaching our last great physical need—need of shelter, we may take either the buildings on the farm found in our work on farming, the store in the mercantile lessons or the mill in the milling lessons as a point of contact. As previously, the point of contact depends on the place of the child's home. Probably one of the buildings on the farm, preferably the house, is best.

The uses of the house, the lumber from which the house is made, the common trees from which lumber is sawed, places from which the lumber comes and how it reaches us, and the houses of the Indian, Eskimo, and Bedouin of the desert, are suggestive of what can be learned in teaching the need of shelter.

This brings us to the second place of home geography in geography teaching which is found in the preparation for the study of earth forms outside of the learner's horizon. This means that home geography has a place in all geography teaching, in the grammar and high school as well as in the primary grades. All geography must begin at home. All geography can not be studied in the grades, hence all home geography can not be studied in the grades. Ritter says, "Wherever our home is, there lie all the materials which we need for the study of the entire globe." Wherever we are there are the great earth elements: atmosphere, land and water. There is also plant, animal and human life; also day and night and change of seasons. On these great geographic elements are based all the details of geography teaching whatever the grade of subject-matter or intellectual attainment of the learner. Hence, to again quote Ritter, "Wherever our home is, there lie all the materials which we need for the study of the entire globe."

It is evident then that whatever geographic form is studied in any grade, we must find the preparation for that study within the child's experience, hence in the geography of his home. Let the subject of study be the great ice invasion of the glacial period of our present geologic era. Evidences of this invasion may be found in nearly every school district of the Empire State. The hills of the district are kames or drumlins, morainic deposits of the conti-

nental glacier. Not far from every school may be found a stream which in the ice age was turned out of its course and in its new course falls over a cliff or precipice producing a waterfall. In many a near-by field, may be found few or many large, rounded and much worn rocks unlike any rocks in the vicinity. These are boulders or "erratics" which were borne to their present resting places by the great ice sheet. Grooves and scratches may be found in the bed rock in many places where the country rock is exposed. These are always parallel and extend in the same general directions. Among the loose rock are often found pebbles with striae. The striae of the pebbles and the groovings in the country rock and boulders all point to a common cause. These phenomena as well as the soil of nearly every locality make up the preparation for the study of one of the greatest events in the world's history—an event which is of great interest to the student of geography, no less than it is to the student of geology. For example, has not the manufacturing industry been a large factor in the making of New England? Is not this manufacturing industry dependent upon the unexcelled water power found almost everywhere in New England? And is not the water power due to the work of the great ice invasion?

In conclusion, the purpose of home geography is to lay the foundation for all geography work and help one to have an understanding and consequently an appreciation of the origin and development of earth forms and their relation to and influence on life. The work in home geography forms a basis for all geography work. The study of the hill is a basis for the study of the mountain, the brook for the river, and the study of earth conditions and life during the different seasons of the temperate zone, for earth conditions and life in the torrid and frigid zones.

To illustrate, take the study of the earth form, a river, beginning with a drop of rain falling from the clouds, trace it till it becomes a part of the river and then the sea, note its relation to and influence on life. This gives one an understanding of the great earth form and consequently an appreciation of it.

LABORATORY WORK IN PHYSICAL GEOGRAPHY

BY ALBERT PERRY BRIGHAM, COLGATE UNIVERSITY

[Abstract]

It is to be understood that field work is an essential part of the practical exercises in this subject. The proportion of indoor and out-of-door work will depend on local conditions, such as climate, available localities, general equipment, and the organization of the school program.

There will always be difficulties in field work, but they will lessen as time goes on. Prejudice against the usefulness or practicability of such work may still exist, but not with disturbing frequency. Double periods, half days and whole days are needed, and in some cases school authorities will have to be convinced that they should afford the needed time. Transportation is usually possible by street car and suburban service, at small expense, and in rural localities the excursions can be made on foot.

The teacher's inexperience in beginning the work, need not give apprehension. The progressive teacher will learn the art of directing field work, by doing it. Almost any excursion will bring a wealth of principle before the teacher and class. The new teacher should go beforehand, and decide on the main points of instruction, and then do the best he can by combined exposition and questioning. The student should take notes, embodying these in a written report, and the excursion should be reviewed in class. The second and third and later trips will develop many comparisons with previously seen phenomena, and general principles will be unfolded by an inductive process.

Perfect correlation with the order of subjects in the classroom will rarely be possible, and it is better to teach all that is within reach on any excursion, as for example, the work of a stream, and any conspicuous traces of glaciation, or effective illustrations of weathering. The teacher need not be afraid of the spirit of the naturalist.

When we enter the schoolhouse, and propose to supplement the textbook with concrete work, the first need is a room, of good size and well lighted. The school desk will not hold the material.

Any good laboratory table, with individual drawers, is the thing needed, and there should be plenty of room for map racks, and trays of specimens. If the whole room is not available, one side of the recitation room, if not occupied with desks and spacious enough for two or three tables, will be useful.

The double period is very desirable, but single periods are better than none, as are even 20 minute exercises in connection with the recitation. The materials of study are all important. Since much of the geographer's material can not be brought into the laboratory, we must depend mainly on representations, such as maps, pictures, and models. Fortunately maps are cheap and of high teaching value. Abundant directions for securing these have been given by several writers. So, too, a few rocks and minerals are inexpensive and can be had by any teacher who tries to have them. And in meteorology much can be done with thermometers, barometers, and weather maps. Laboratories are not yet numerous in our subject, but they are increasing in number and models are not hard to find. A visit to a well equipped laboratory in a high school or college will be useful to teachers having such work in prospect. The work once well begun will insure its own extension and can now be done to some purpose, not only for its educational value to all, but because it can now often be offered, in entrance to college. The College Entrance Examination Board will, for the third time, set an examination in the subject in 1904. In this, 40% of the count depends on the laboratory notebook.

THE PLACE OF COMMERCIAL GEOGRAPHY

BY JACQUES W. REDWAY F.R.G.S. MT VERNON

[Abstract]

In the systematic course of study in geography we have come to accept the fact that human history is very largely a quantitative statement of climate and topography. The influences of geographic environment so strongly tincture political history that a knowledge of the former is absolutely essential to the interpretation of the latter.

We are not quite ready, perhaps, to admit that, in the past few hundred years, commerce has been the point of view in most of the great movements that go on record as human history, yet a brief inspection of any one of them will disclose the fact that commerce was the initial motive. The discovery of an all water route between Europe and India is an example. The blockade of the trade routes over which commerce had passed for the preceding centuries led to a search for a route that the Turks could not disturb, and the result was the voyage of Vasco da Gama. The readjustment following the utilization of this route was world-wide. It drew the trade away from Venice and Genoa and landed it at the shores of the North and the Baltic seas. The concentration of commerce in this new field encountered opposition from the feudal lords for a time, but when the smoke of contest had cleared away, there was no feudal system. The new empires were founded on commerce and the divine right of the king was a forgotten fetish in western Europe.

The discovery of the American continent was another result, though incidental, of the blockade of the trade routes between Europe and India and we are today witnessing the readjustment of the whole world because of the demands of American commerce. Each war in which the United States has been engaged has had a commercial basis. The War of the Revolution gave us the political independence that made commercial development possible and, indeed, political revolution is almost always an answer to the demand of commercial evolution. The War of 1812 gave us commercial independence. The great Civil War resulted from the restrictions on commercial development namely, the commerce of cotton. Incidentally the invention of the steam engine followed by that of the cotton gin transferred the cotton-growing industry from Hindustan to the United States and made the latter the world's chief source of the cotton fiber.

The commerce of foodstuffs between the Mississippi valley and the Atlantic seaboard brought about the evolution of the railway. The great tax on the railway, to which the crops were delivered

for transportation faster than they could be readily carried, demanded the abandonment of the wrought iron rail and led to the discovery of the Bessemer steel process and the steel rail. To correct the defects of the iron rail was the only end that the railway manager sought. He did not dream that the steel rail was to span the continent within a very few years and again revolutionize the world's commerce, but this was to be the result. Bessemer steel played a greater part in the unification of Germany than even the army of Louis Napoleon at Sedan. A similar result and one quite as far-reaching followed the building of the Northern Pacific and Great Northern Railways. These lines were constructed in order to develop certain possibilities of trade between the Atlantic seaboard and the states of the Pacific coast. When, however, these lines were thoroughly organized there unexpectedly resulted a new trade route that is drawing traffic away from the Suez canal and landing it at Asian shores by way of the ports of Puget sound.

Only a few years ago the demand for sugar increased so greatly that the supply began to fall short of the demand, and in order to meet the demand the sugar contained in the common beet was brought into requisition. It was found, moreover, that the sandy plain on the south of the Baltic sea was the place most favorable for the growth of the sugar beet; indeed, no better place in the world exists. In 1900, two thirds of the world's output of sugar came from the sugar beet, having been produced at a cost of about 2½c a pound, or $50 a ton. In the tropics the yield of cane sugar an acre is about double that of beet sugar and it is produced at a cost of about $45 a ton. The difference is offset in part by the fact that raw cane sugar must pay transportation a long distance to the place where it is consumed, and in part by the government bounties paid on the beet product.

Because of the bounty thus paid both the economic and the political effects of beet sugar manufacture have been very far-reaching. In Germany there occurred a reorganization of agri-

cultural industries that involved a very large part of the empire. The uncertain profits of cereal crops and sheep grazing gave place to the sure profits of beet sugar-growing, and thousands on thousands of acres of cultivable land were turned from the former to the latter. Even the Netherlands, the home of the cane sugar industry profited by it. The income of the Germans was enormously increased by the venture.

In the case of Spain the result was disastrous. The price of cane sugar in Cuba and the Philippine islands fell to such a low point that the islands could not pay the taxes imposed by the mother country. Instead of lowering the taxes and adjusting affairs to the changed conditions, the Spaniards, by their oppressive management drove the islands into the rebellion that finally provoked the interference of the United States and resulted in the war by which Spain lost her colonies.

The foregoing illustrations are neither strongly drawn nor far-fetched. They represent a fact that is not often sufficiently emphasized--namely, that no people can live wholly within the political boundaries that on the colored map mark them as separate and distinct from another people. From an economic standpoint few such boundaries exist. Civilized man draws on all the rest of the world—not alone for the luxuries but for the necessities of life--and gives to all the rest of the world in turn; moreover, he is civilized because of this interchange and not in spite of it. Now this interchange of commodities constitutes the science of commerce. Commerce must move along lines of least resistance, that is along lines of the most favorable topography; the commodities themselves, as a rule, must exist between lines of temperature, soil and rainfall. And day by day the world is becoming relatively so small that the disturbance in the movement of a product in one part of the civilized world is invariably followed by a readjustment to the changed conditions in all other parts.

Tuesday morning, Dec. 29

SECTION MEETINGS

Section A. PHYSICS AND CHEMISTRY

PHYSICS, LABORATORY AND MACHINE SHOP EXHIBIT[1]

BY PROF. O. C. KENYON, SYRACUSE HIGH SCHOOL

In the first place, I wish to say, that owing to our regular school work, we have not had sufficient time to arrange all of the apparatus as we wished it to be, nor to include all of the experiments that we should otherwise have been glad to show.

As it is, however, we have prepared the apparatus for about 90 laboratory experiments, 50 or more of which have been performed during the hour by our pupils; and in the machine shop we have shown about 25 operations, useful in making and repairing apparatus. My aim has been to show by the exhibit, or to learn by discussion, the best apparatus and the best method for each experiment. We sincerely hope that you will find all the fault you can with our equipment and work, because in that way we shall all be most benefited.

I will begin the criticism myself by saying that our notebook is too small (6x9 in.). With it pupils are inclined to crowd their notes into too small a space. Next year, we shall use a larger size.

You probably noticed the lack of fixed table supports. The brass plates and rods which are being made in the shop are expected to help supply our need in this direction. Personally, I do not like the heavy timbers seen above some laboratory tables.

I will now speak of a few experiments in which we think we have made improvements.

First, concerning steam. Our supply is directly from the boiler in the basement, so that we always have steam at any desired pressure, besides distilled water at any temperature. Wishing to use this steam for individual work, I connected to a steam outlet an old gas pipe having several stopcocks. At first,

[1]These notes were written a few days before the meeting of the association, in response to a request from the secretary that some account of our laboratory exhibit be prepared by me for publication in this report.

the amount of water that entered the calorimeter trap caused trouble, but on making an exit for this water through the bottom of the trap, by means of a rubber tube and pinchcock, I found the problem solved. The apparatus required for heat experiments is thus much simplified, apparatus A and the bunsen burner being dispensed with.

The steam pipe can easily be extended about the room, and steam be supplied to each pupil, just as gas, water and electricity are now furnished to each.

In experiments with photometers, lenses, and concave mirrors, we find incandescent lamps much superior to the kerosene lamps we formerly used.

A power dynamo, of low but constant E. M. F., for laboratory work is convenient and reliable, saving much time and annoyance with batteries. Our dynamo for this purpose is of 20 volts E. M. F., and 20 amperes current.

After trying many plans with Atwood's machine, I have a method that works well with even a cheap form of the apparatus. The trouble with this experiment, and with the use of the inclined plane for the same purpose, has been that we have expected too much from them, or rather from the young experimenters who have tried to do the experiments. Without electrical contact between the pendulum and the falling body at the end of each time unit, the pupil can not accurately enough measure the required distances. But the experiment is valuable, almost essential, for making clear the meaning of the terms acceleration, velocity at an instant, average velocity and distance in a particular unit. A class experiment does not take its place.

My plan is this: first balance the resistance due to friction by means of a piece of wire placed on the side which is going down, so that, after starting the weights without any rider, the velocity is uniform. Then obtain, yourself, the distances through which the rider carries the weights in one, two, three, and four units of time respectively, and also the distances passed over in the second, third and fourth units, respectively, the rider having been caught off at the beginning of the units named, in turn. These values

are given to the pupil, and he is asked to verify them, to show their relation to the terms used in accelerated motion, from them to obtain the values of the other terms used (no formulas being used), and finally to illustrate by the values thus found the formulas for motion, momentum, force and energy; each term used being meanwhile carefully explained or defined, and the proper unit for each quantity being also named.

While this experiment differs from all of our other experiments, in that the pupil is not required to make independent measurements, it is nevertheless valuable in clearing the pupil's mind, and is by no means too easy.

I will close with two thoughts as to the general character of laboratory work.

1 The best apparatus is none too good. The beginner in science should be given tools that, if carefully used, will give accurate results. For example, does anybody think that the vernier caliper is not a better instrument to give to pupils for obtaining the diameter of a sphere than the two blocks and rule so commonly used?

2 Of two experiments, is not the one giving the more accurate result to be chosen, even when it is less direct and simple in its method than the other? To illustrate: the common method of obtaining the velocity of sound out of doors by striking a bell or something similar, though more direct and simple than the resonator method, is much less accurate, and may be carelessly done without detection. Of the two methods then, is not the one making use of the resonator the more valuable? I would like the opinion of some college men on this point.

NEW APPARATUS FOR ILLUSTRATING COLOR PHENOMENA

BY PROF. ERNEST R. VON NARDROFF, ERASMUS HALL HIGH SCHOOL, BROOKLYN

With the ordinary method of combining colors by means of rotating paper disks, the luminosity of the combination is only an average of the luminosities of the components, instead of being their sum. This is often very inconvenient. Thus in trying

to show that the three primaries, red, green, and violet blue, make white we can only show a dull gray; or again, instead of getting a clear yellow by adding red to green we only get a mean yellow brown. The effects, it is true, are somewhat improved by the use of rotating glass disks projected on the screen, but we are in that case limited by the difficulty in varying the relative proportion of the component hues. It was to remedy these defects of the older experiments that the newer ones were planned.

This apparatus, which was constructed by our instrument maker, Mr F. W. Huntington, when placed before an ordinary lantern converts it into a triple lantern. And it does this in such a way as to allow the three beams to be colored by means of glass slips, to be moved about on the screen independently of each other, and, what is of prime importance, to be separately diaphragmed down with a uniform intensity.

I will now take the apparatus back to the lantern and show a few experiments with it. I remove the focusing lense of the lantern, and also the front lens of its condenser, thus getting a parallel beam. In this I place the apparatus. Then on the screen you see three similar disks of white light. Making these disks overlap in triangular fashion we see intensities that are in the ratio of one, two and three. Drawing the disks apart I color them with these special glasses, red, green, and violet blue. Notice how saturated the colors seem. We must now secure a perfect overlapping of these disks. There is no difficulty in getting the first two, red and green, exactly to overlap, but in swinging over the blue you notice it passes a little to one side. A second adjustment has been arranged to control this matter. There, with a slight turn of this screw we have secured an absolutely perfect overlap of the three hues. But the resulting hue? It is not a pure white though of high luminosity; it is distinctly greenish. The green beam is too powerful. Slowly contracting the diaphragm of the green beam the white is much improved, and a touch at the red makes it perfect. That looks like a patch of ordinary white light on the screen, but you can see its peculiar composite nature by looking back at the apparatus itself. See

these colored beams marking their paths through the dust of the room. Or again, placing my hand several feet in front, see the strangely colored shadow on the screen. It is no mean mental exercise for a pupil to explain each of the six hues besides black and white that we see.

But now to fundamentals. I will now slightly separate our three beams from each other. I see that the white center of the triangular figure is no longer a perfect white. The lantern light may have changed slightly, but with a judicious touch at the diaphragms we are all right again. Besides the white, the figure presents us with the mixture of our primaries in pairs, the so called secondary hues, purple, bluish green, and yellow. Let us study one of these secondaries more clearly, choosing the yellow. Notice how brilliant it is. I have now closed all the diaphragms except the green. Slowly turning on a little red, we observe that the overlap appears a yellowish green. With more red we get a lemon yellow and then a full yellow. Further to increase the proportion of red I next turn down the green and as a result the yellow passes through an orange yellow, a full orange, and thence on to red. Similar experiments may be tried with the other secondaries, but let us pass on to the subject of complementary hues.

There on the screen is a yellow at the overlap of the red and green, and off at one side is the blue. Shifting the blue over the yellow we get a white, and so conclude that yellow and blue are complementary hues. In the same way we see that red and bluish green are complements, and so are green and purple. In each case the white produced is seen to involve the three primaries, red, green, and blue.

The question as to the distinction between mixing colored lights and mixing pigments may be very easily illustrated with our apparatus. I color one of the beams with this film of yellow gelatin and shift it so as to overlap the blue. With a little adjustment of the diaphragms we get a good white without the slightest trace of green. But to make sure of this I turn on a third uncolored beam and bring it nearby. You see we have no diffi-

culty in adjusting its luminosity so as to make a perfect match. We have gotten our white by addition of blue and yellow lights. Now for pigment mixture. Of course it is well understood that the colors of our glasses and gelatins are due to selective absorption, and the same is true of pigments which may be regarded as transparent mediums in a finely divided state. It is also well understood that the unabsorbed light passing through a piece of yellow glass for example is generally complex, representing various portions of the spectrum. What we observe is the mixture of these unabsorbed hues. Now it happens that most yellows and blues transmit a certain amount of green among other hues, and that this green is the only color common to the absorption spectrum of both. I know that to be the case with the yellow gelatin and blue glass we are using. Placing the same two colors then superposed in the same beam, we observe on the screen a dark green as we should have predicted. And so we get from the yellow and blue either a white or a green according as we arrange to add lights or to add absorption. This is the most common result but I may say incidentally that I have in my possession a series of pairs of blue and yellow mediums that by their superposition yield every hue of the spectrum.

To illustrate color contrast I throw on the screen a green beam, and slightly overlapping it I turn on a dull white. The white appears distinctly purplish, or the complement to green. Or again, I project a blue beam, and now the same white appears yellowish.

I see I have reached the limit of my time allottment and so must allow these few illustrations to suffice. Indeed now that you understand the working of the apparatus, you will without further explanation see how tints, browns, and broken tints generally may be obtained, though I ought to say that in many cases it is necessary so to arrange the experiment that the color shall be surrounded by a white of full luminosity to serve as a standard of comparison.

DEMONSTRATION OF RADIUM

BY PROF. WILLIAM C. PECKHAM, ADELPHI COLLEGE, BROOKLYN

The announcement of my subject releases me from any lecture or formal statement even regarding radium, and permits me to proceed immediately to show you what I have to show. The metal uranium[1] has been known for about seven years to be capable of emitting what have been called rays, though these rays differ from what we have formerly called by the same name. The rays of heat and light are undulatory motions, passing through a medium, the rays of radio-active bodies are believed to consist of particles, solid or gaseous, shot out from these bodies. These particles may be as small as the thousandth part of a hydrogen atom, but we give to them space and velocity and can see the effects of their motions. They are projectiles, tiny indeed, but projectiles, bombarding resisting walls and spending their energy against restraining barriers.

Attention was next drawn to pitchblende, an ore of uranium, with the result that new materials, elemental substances they are thought to be, were brought to light. Thus radium was discovered by the Curies of Paris. Here is a bottle of radium which was imported soon after the discovery of the substance. It is of a low power. It will affect a photographic plate. Here is a negative made with it by an exposure of 90 hours. A copper cent and an L of lead have cut off the radiations which have affected the rest of the plate. This sample does not shine sufficiently to be seen in the dark, but it has colored the glass of the bottle in which it has been kept with the decided and characteristic pink tint.

This slide showing the letters A. C., for Adelphi College, was made with letters cut from lead, by an exposure of seven days to the piece of pitchblende which I have shown you. The plate was of course wrapped in black paper to exclude all ordinary light from access to it, and the exposure was made in a completely darkened room, whose walls are painted a deep black. The area

[1] When any substance was named a sample of it was shown, and when an effect was described that effect was produced by an experiment.

of the plate which developed in the photographic bath conforms in shape to the piece of pitchblende, and even disclosed the presence of impurities in the mineral by their insensitiveness, in that these fail to affect the plate and appear as white spots on the glass after development.

The next mineral is gummite, perhaps a disintegrated pitchblende, found associated with pitchblende. It is radio-active, though I have not had time since I obtained the specimen to make a picture with it.

I shall exhibit the fluorescence of a number of minerals in the rays from the tube of radium; but before doing this I will show the same minerals and their fluorescence in the ultraviolet rays from a Piffard lamp, in order that you may see them in both aspects. The Piffard lamp employs the discharge of an induction coil across a series of gaps between iron balls, four in number. The strange bluish light which is seen is due to the arc produced by the burning of a minute portion of the balls. It is therefore an iron arc at which you are looking, and it is very rich in ultraviolet rays. Here is then the fluorescence of the newly discovered mineral, kuntzite, which requires quite a time to receive the rays, but which then shines brightly for a long while afterwards. These which follow are willemite, pectolite, hyalite, phosphorescent zinc sulfid, the ammonio-oxy-fluorid of uranium, and barium platinocyanid, the substance generally used as a fluorescent screen in Roentgen ray work. I also add two well known substances by way of comparison, though they do not respond to the excitation of the radium tube. They are uranine and quinine, the former in an alkalin solution and the latter dissolved in very dilute hydrochloric acid. In this way very strong solutions may be prepared. The first produces a very strong greenish color, and the latter a very rich blue.

I have here today three preparations of radium. The older tube I have already shown you. In this second tube is a quarter of a gram of very strong radium bromid. It is from the hands of the Curies themselves and is rated by them at 7000. The tube which I have ordered for Adelphi College, not having arrived in

season, we are greatly indebted to Messrs Eimer & Amend, the importers of New York city, for the loan of this tube. It was released from the customhouse only on Saturday evening last, and I have not had it long enough to perform many tests with it.

I have also this instrument, the spinthariscope of Sir William Crookes. It is as you see a tube of brass, at the bottom of which is a screen of calcium sulfid, which fluoresces in the B-rays of radium continuously. Above this screen swings a small index, like the hour hand of a watch in shape and size. The instrument is completed by a small lens like a simple microscope, which magnifies the field. The tip of the index has been touched to a solution of radium of 300,000 power. When in deep darkness the eye has been freed from gross light, the play of the scintillations from the screen are simply marvelous. A shower of sparks (σπινθήρ, a spark) are seen like meteors streaming across a midnight sky. These are due to the blows given to the screen by particles shot out from the substance of the radium itself. These are the A-rays, consisting of heavy particles, which strike a blow many times as heavy as can be given by the minute particles of which the B-rays are composed. Each particle is like a small projectile striking its target with such an enormous velocity that it is seen to strike out sparks of fire by its impact. It is to these particles that the heat of radium is supposed to be due, so that it is kept about 5° F. above the air by which it is surrounded. The exhibition of the spinthariscope is of course an individual matter, and can only be enjoyed in its full richness by remaining in a perfectly dark room for some minutes. It is better to keep the eyes closed even in the dark room till the eye is placed before the instrument and the rays admitted directly into the empty orb. Then one sees as it were, "a large globe in which are moving innumerable flashes of fire as objects move in a kaleidoscope."

The tests of radium are principally three in number, the first being the emission of light in the dark. This is very faint and not, as the newspapers have represented it, bright enough to

replace the sunlight. The second is the effect upon a photographic plate. The third is the discharge of an electroscope.

The charged gold leaves are now projected on the screen before you. On presenting the tube of radium to the ball of the electroscope, the air in the vicinity is rendered a conductor of electricity and the electricity passes off as is evidenced by the gradual collapse of the gold leaves. You now see them hanging limp side by side.

The ability to emit light may now be seen. Everyone within 10 feet of this tube should see it glow, with a faint light, not so bright as a firefly. Its power to excite fluorescence in other bodies, is seen while I hold the tube behind a screen of barium platinocyanid. This can be easily seen all over the room. So also when the tube is held near the piece of willemite. This is the brightest of all. The interposition of a sheet of metal does not reduce the light very much. My time is exhausted, but not my subject. The examples which I have given you show the nature of the phenomena of this strange substance, and doubtless arouse in our minds speculations which no one at present can answer.

Section B. BIOLOGY

ADVANTAGES OF A YEAR'S COURSE IN BIOLOGY (ZOOLOGY, PHYSIOLOGY, BOTANY)

BY WILLIAM DAYTON MERRELL, UNIVERSITY OF ROCHESTER

This is an age of science. The contributions of applied science to the comfort and elegance of our daily lives have been so vast as almost to defy enumeration. This is a practical age. Hence, with the great advances in the direction of applied science, there has come a demand for a fuller study of pure science, not only because scientific principles must be known in order to be applied, but also for its own sake, as an essential element in a liberal education.

This latter demand was for a long time satisfied by what was known as a "culture course," the idea being that by a series of lectures and assigned readings an instructor could put his eager classical students in touch with the results of scientific research.

It is a just cause for regret that in some quarters of the earth this kind of culture course has not yet become extinct.

A long step in advance was taken when these culture courses were supplemented by practical work on the part of the student himself, the purpose being not so much to store his mind with interesting facts, as it was to lead him, by direct contact with the objects themselves—which are the real facts—to an appreciation of the methods of original scientific work, and of the laborious processes by which the generalizations of science have been reached. It was right here that the supreme opportunity was given to science to demonstrate its unique value as a part of our educational system. Up to this time the average student in science had gained little of real value beyond the smattering of information by which he could make small talk in society, or illustrate his sermons. His knowledge of facts was acquired along the path of least resistance, the memory, resulting in the partial atrophy of other important mental faculties. Now, eye and hand must be trained to do the bidding of the mind. The student must learn to be accurate as an observer, discriminating between the essential and the nonessential, the typical and the abnormal, honest in making his record of observations, candid and logical in the conclusions drawn from these observations.

Of all the sciences which have lent themselves to this method of study in the high school, none is more important than biology, since it stands in such close relation to our own personal welfare. We are the youngest of them all, and yet it is inspiring to glance back over our history, looking at it for the present entirely from the educational point of view. It is interesting, also, to note the closely parallel lines along which our educational ideals have passed in the two coordinate branches of biology—zoology and botany.

Glancing first at zoology, we see how, even within the recollection of many present, the best schools were contented with a method of study which trained only the memory. Systematic zoology, or classification, lent itself readily to this style of treatment, and was almost universally taught. Then, when the insuffi-

ciency of illustrative material as viewed from the teacher's desk began to be felt, specimens were handed out to the students—at first for mere external examination, and later for internal study (dissection); and since only a limited number of forms could be studied in this way, we see morphology fairly installed as the subject-matter, and type study as the special laboratory method. At first this was used merely as an aid to the understanding of the broad outlines of classification; but as the teachers found that the students were more interested in a structure when they knew what it was for, more and more attention was paid to function, or physiology. Today, most of our schools are teaching this kind of zoology, and opinion is quite evenly divided as to whether the chief attention should be paid to the study of the structure of a series of animals, or to their life habits. What we might call the "new zoology"—the study of the adaptations of animals to their environment, or ecology—is a natural outgrowth of the increasing attention which has been paid to the study of function.

Turning now to botany, we need not spend much time in telling how long the classification of plants was regarded as the highest goal for the ambition of the investigator, as well as the proper work for the beginner, and a refined and uplifting recreation for amateurs in every walk of life. Indeed, botany remained so long the "gentle science," that even today, in some quarters, it is hardly considered a worthy occupation for men. Further, systematic botany, as taught, was confined to the study of the flowering plants, and when its immediate successor and partial contemporary, structural botany, came into prominence, that also was limited in its application. Imagine a class in zoology beginning its work with the comparative anatomy of vertebrates! A more rational treatment of plant anatomy soon brought it into its proper relations to classification and development, and we reached, at last, a true morphology. Greater attention was now paid to the flowerless plants. The "dirty scums" of the pools were found to consist of objects full of beauty and interest. The bark of the trees, the dirt in our flowerpots and greenhouses, the dripping rocks in our glens, all had their part to contribute to

the new-old study. Then the inevitable happened in botany, just as it had in zoology. No teacher can arouse much interest in mere structure, if its function, the reason for its existence, is not understood. It was a professor of Latin in one of our large universities, who, scarcely five years ago, asked a botanist what possible connection there could be between physiology and botany! There is a very real connection between them, and our Latin professor might do well to glance over the rapidly increasing number of excellent textbooks and laboratory guides in plant physiology.

Thus far, if the truth be told, botany was merely following in the footsteps of zoology. But we can now show where botany has at last taken the lead. Kerner's *Natural History of Plants* is an old book, but it is read more and more every year. The work of Haberlandt on the physiologic anatomy of plants, and later that of Warming on ecologic plant geography, have brought into prominence a phase of botanic study so natural that we seem to have known it always, so interesting that we might well be asked why we neglected it so long. The teaching of zoology had long been established on a basis of morphology and physiology, when the work of the botanists stimulated their brethren to an increased attention to the questions of animal ecology. Thus, in the Twentieth Century Series, Jordan's *Animal Life* follows Coulter's *Plant Relations*. Note, also, the increasing interest in the study of the habits of birds and insects.

In physiology, also, there has been an advance, specially when, as will be shown later, it has followed a course in zoology. In former times far too much time must needs be spent in the study of the anatomy of the body, and the writer can remember distinctly the hard work he had to make a poor memory keep such things as the bones of the body and the cranial nerves in proper order. Today, while we are still obliged to know the structure of the body, we are paying more and more attention to the functions of the various organs. This gives us a much better foundation for a rational instruction in hygiene, a condition which we all welcome, even though we may think that the alcoholic appendix is abnormally large!

Then many of us are finding an increasing satisfaction in teaching what is known as cell physiology. Without going at all into details, this is a universal, a general physiology, its data being derived from the study of plant cells as well as those of animals, its conclusions being applicable alike to both. Treated thus, human physiology is but a special phase of a much more general subject. It may be said with safety that this is the highest form of physiology, since it makes it a part of the general science of biology, coordinate with general morphology.

In this hasty sketch, no attempt has been made to point out the specific influences of one science on the other, except in the most casual way. We may now consider some of the influences which each of them has exerted, or may exert, on the others.

The study of zoology has, as we have seen, passed from systematic zoology to morphology and physiology. How does this affect human physiology? First of all, the study of a series of graded types gives the student a knowledge of comparative anatomy, so that when he comes to physiology he need not spend so much time on the anatomy of the body, but can pay more attention to physiology proper—a practical gain of very great importance. Then, too, it gives a chance, by the study of the lower, simpler forms, to learn the essential nature of the fundamental physiologic functions of the body. Nutrition, respiration, irritability, all are seen in the Protozoa, reduced to their lowest terms, separated from all complicated anatomic machinery. Nutrition is the nutrition of the cell; respiration is the respiration of the cell. In the higher animals there is simply a division of labor between the different kinds of cells. Ask a class in physiology the fundamental purpose of respiration, and how often the answer will be, "to purify the blood"! But if that class had been studying the respiration of a graded series of types from Amoeba up, it would see that what the physiologies call internal respiration is the real respiration, the respiration of the cells, and that the question as to whether the gas exchange (external respiration) shall be effected through a moist skin, as in the earthworm, or by gills, as in the crayfish, or by lungs, as in man, is simply one of adapta-

tion to a particular environment, the blood being in all cases a medium of exchange between the outer world and the cells which are in the interior of the body. This is but a single illustration of the importance of a comparative study of the physiology of the types used in zoology.

That zoology has by a good example in times past helped to bring about much needed reforms in the teaching of botany, can not for a moment be doubted. We have already shown how much earlier zoologists adopted methods of teaching which are of standard value today. Botanists have done well to follow their lead. It stands to reason, too, that a well trained zoologist, carrying over to his botany class the results of the careful work and methods used in zoology, will produce equally good results in botany. But it should be emphasized right here, how grievously botany has suffered at the hands of those self-styled "biologists" who are in training and sympathies merely zoologists, and whose knowledge of botany comes from a day or two spent on Protococcus and Spirogyra and a long forgotten course of Gray's *Lessons*. When a trained zoologist carries his methods of work over to the botany, his work will be well done. But teachers of the type just mentioned hurt botany, because they misrepresent it. We botanists ask for no better training in botany than in zoology, but we do ask for just as good.

In speaking of the influence of physiology upon zoology and botany, it is admitted by every live teacher that physiology is to a good course in either zoology or botany very much what the juice is to an orange. With it, there is plenty of life and interest. The trouble with our old style botany courses was that, in our administration of the legacy handed down to us by Professor Gray, we made the mistake of leaving out the physiology. The result was that dried plants were considered nearly as valuable as living ones, and often even more valuable, and we became mere dealers in baled hay!

Then, too, the higher physiology, the physiology of the cell, acts as a valuable check on the teacher, who must be careful to employ terms in describing the physiology of the plant in the same sense

in which they were employed with animals. For example, if he has taught the proper meaning of digestion and assimilation in zoology, he will be obliged to stick to his definitions when he comes to botany. After a good course in animal morphology and physiology, a teacher (or a textbook) ought to expect trouble with a bright class if they are told that water and mineral matter and carbon dioxid are "digested" in the leaf. And the trouble ought to be heated seven times hot for those who persist in retaining in any form the word "assimilation" in connection with the process of food manufacture in the green plant. The one defect in what is in other respects an admirable elementary text, is the retention of that misleading word, even going so far as to call it in one place "assimilation proper," with no apology for it beyond the mere use of quotation marks. Again, if respiration has been correctly defined and explained in zoology and physiology, it will be easier to draw the distinction between that process and photosynthesis in green plants; and each process can be better understood if the cell is looked on as the working unit.

In what way has botany helped the other sciences? Certainly, by having its attention called to the advantages of a study of the habits of living things and their special adaptations to their natural environment, zoology has been made more of an outdoor study than it had been for some time past. This is surely a step in the right direction, since it takes the student out into nature's great laboratory, and at the same time teaches him to respect the lower forms of life, by showing him that each animal, likewise each plant, has its own life problems to solve. By studying the animal or plant from the standpoint of its own personal well-being, the student is made less selfish in his attitude toward the world in which he lives.

Then, too, whatever we may say in regard to the subject-matter of the old botany, the painstaking accuracy of the older workers was not without its effects on those working in the other science. The first conception of the cell theory itself came as the result of the study of plant tissues.

We have already pointed out some of the mutual relations between botany and physiology. We may simply add here that we know far more regarding the chemistry of animal digestion as the result of the work of plant physiologists.

It may be thought that most of the considerations presented are more theoretic than practical, but surely they are not without a practical bearing. In studying the practical benefits to be derived from a combined course in zoology, physiology and botany, we can see that some of them will be direct, others indirect. The direct advantages of the combined course in any one year will depend, of course, on the actual order in which the subjects are taken up. If zoology precedes physiology, the study of the comparative anatomy and physiology of the lower forms will aid materially in the intelligent study of human anatomy and physiology. Thus opportunity is given for a careful study of many topics which must otherwise be slighted for mere lack of time. The way in which botany will be benefited by the previous study of zoology and physiology, has already been pointed out.

But the advantages of such a combined course are not at all confined to any one year. Such a course can not be given year after year without exerting a most profound influence on the teacher. If the three subjects are taught as parts of a larger, broader science, as they really are, the teacher will see more and more clearly the many points of contact between them. And as his own horizon expands, he will impart to his students a much broader conception of life in all its varied forms and manifestations: and this is the supreme object which we hold before ourselves in all our educational work.

William L. Fisher—The advantages of a year's continuous course in biology over the present method of teaching the subjects, are so very evident that it seems almost unnecessary to attempt a discussion of the topic. Still, a statement of some of the chief reasons for a change may make us realize more clearly the faults, if any exist, in our present scheme, and the ways in which we may add to our usefulness.

That the biology course, as it is now given in the majority of the schools, is unsatisfactory, will hardly be questioned. Too many of our pupils, and of our fairly well educated people outside the schools, do not even know of what the subject treats. Too many of the teachers in our schools, who are working in other departments, fail to realize the importance or the value of this science, and wonder why it should claim any place in the curriculum. You have probably been asked, as I have been, "What is the good of studying biology? Has it any bread and butter value? If a boy can not earn his living by it what reason is there why we should make him study it in school?" This idea is, of course, passing but that these questions are still asked is a fact that most of us have been made to realize.

Probably all of our schools give a course in physiology, many offer a short course in botany and some give a half year to zoology. Still is it not often true that the physiology is given when the pupils are too young to get more than the most elementary facts of anatomy and hygiene; that the botany class neither attracts nor holds a large number of the pupils; and that the zoology course has no recognizable connection with either of the other two? In one large school of my acquaintance, the only apology for a biology course was a half year of physiology in the second year, and in the sixth, or senior year two weeks of botany for the few boys who were going to Yale.

If we are to substitute for the present method of teaching the three subjects separately, a continuous course, for one year, in biology, we must first be certain that the change will be an improvement. To decide this we must look at the question with reference to the two classes of pupils in our schools: those who go from school to a college or university, and those for whom the high school is the highest school.

For the prospective college student the continuous course will possess the advantage of giving him the three parts of the subject as a connected whole, and in their logical sequence. He will have some idea of the relations existing between the different life forms, and, if the course could precede or follow a similar course in

geology, some idea of the life history of the earth. Then, when he enters his college, there will be some foundation for future work in the same lines. The college professors in physics and chemistry, expect to get, and do get their pupils with a fairly good elementary knowledge of the subject, and often with a working knowledge derived from a course of experiments. The biology professor has, too often, to lay the foundation before he can build anything on it. This, of course, takes time and so makes possible less advanced work, and all individual research has to be pushed over into the postgraduate university course.

For this class of pupils, the quickest way to gain the end would be to include biology among the college entrance requirements, or to accept it as a substitute for some other subject.

What then will be the advantage of the biology course for the pupils who go no further than the end of the high school curriculum? They will gain, with the others, the idea of the relation between the three parts of the science. They will get, what many schools now do not give, a chance to study all three subjects instead of only one, or two. The boys will find that botany is not what they call "a girl's study," and that it means much more than simply collecting and pressing a few pretty flowers. The girls will find that even earthworms may be interesting and that there is a difference between a moth and a butterfly.

By far the greatest advantage, however, will come from the giving to our pupils the great and broadening thoughts of the relations of life forms and of life development. We teachers are too familiar with the doctrine of evolution, and the ideas that are associated with it, to remember that the boys in our classes are learning these truths for the first time, and that they may find them hard to understand. We forget till some questioner reminds us that in our teaching we have been going faster and further than our class could follow.

The old popular fear of natural science as heresy, and the idea that the scientist is necessarily an atheist, has, of course, nearly passed. Still enough of it remains to make necessary the recognition of its existence, and to insure a welcome for any change

in our schools that shall hasten its complete disappearance. Outside of our university towns and centers of learning, are still to be found preachers who will give to their people a tirade against science teaching in all its forms and methods, and will particularly warn their young people against any belief in the doctrine of evolution, on pain of losing the very foundation principles of the Christian religion. What is still more unfortunate, this kind of preaching is not confined to the old men, but some of our theological seminaries are still sending out young men with these old ideas as a part of their intellectual equipment.

We may say that this is foreign to our subject. That our business is to teach science and not religion or morals. But at the same time we know that our business is not simply to instruct our pupils, but to educate them, and that if we fail to give them all the help that we can toward becoming men and women of the highest, truest type, we are not doing our whole duty as teachers.

If the continuous course in biology is going to give us the chance to present the facts of life and of life development to our classes in any better and more comprehensible way than is possible under the present system, by all means let us change our methods.

Münsterberg says that the development of natural science, like the development of the church, has passed through alternating periods when they had golden priests working with wooden chalices, and wooden priests with golden chalices. He says that the middle of the last century saw a period of the first kind, when Darwin, Spencer and Huxley were doing such wonderful work, with such poor and meager equipment. But now we are in a period of the other sort, with extensive apparatus and fully equipped laboratories, but unfortunately, too many teachers of the order of the wooden priests. Our intense specialization, and minute subdivision of our subjects, have robbed us of the broader views and expansive thoughts that might come from a more general, if less exhaustive study of the sciences in their larger aspects.

Dr Chamberlin thinks that the time is coming when the specialization that now marks our scientific study will be, in a measure given up; and when our students, instead of being botanists,

zoologists, or physiologists, will approach more nearly the type of the older naturalists. If that is the direction in which our education is tending, then the substitution of the biology course for the three subjects taught separately is distinctly a step in advance, and is a mark of the forward movement of our pedagogic methods.

Prof. J. E. Kirkwood—A course in general biology is certainly of great value when properly conducted, but for the best results, I would not stop there. A full year in botany and the same in zoology ought to follow such a course. I find that one half year is quite inadequate for a successful presentation of the subject of botany giving two hours a week to the subject, but I am able to arouse far more interest in that science in another course of three hours a week lasting through the year. The need of more thorough work both in botany and zoology in the many of the secondary schools would be apparent to any one who had occasion to examine many notebooks in these subjects presented for entrance to college.

BIOLOGY AS A CULTURE STUDY

BY PROF. W. M. SMALLWOOD, SYRACUSE UNIVERSITY

No one cares to be regarded as a barbarian. In appearance few people adopt customs or ignore styles to the extent of becoming noticeable. This is the least likely of the barbarisms to be assumed. But there are barbarisms of the mind, some that are assumed, some that are innate. What is a man's attitude of mind not only in regard to the subjects and new discoveries that belong to his realm of thought but also to the new discoveries outside and beyond his special training? In other words does he give evidence of barbarisms in his thinking or does he receive new ideas in a generous manner, placing truth above dogma and giving evidence of a willingness to trust the future?

Culture has to do with the temper of the mind rather than its accumulated information, and of course is associated with those things which are the "noblest and best." "True culture," as one has well said, "consists in bringing people into a certain attitude of mind rather than of informing them of facts." President Eliot

in his address before the National Educational Association, states that we may judge of culture by its results. The "best results of real culture ... are ... an open mind, broad sympathies, and respect for all of the diverse achievements of the human intellect at whatever stage of development they may be today—the stage of fresh discovery, bold adventure, or complete conquest." This conception of culture is such that it may be approximated by every one and its foundation is laid in the high schools. Of the subjects pursued there, the sciences, and specially biology, tend to lay the foundation for a mind open to perceive and to interpret facts.

The time is fast passing when the determining factor in culture is based on a study of given subjects; and likewise the time is passing when any one set of subjects has a monopoly in training the mind. We are beginning to recognize that the real value of a subject depends on what it does for the individual; does it stimulate him to do independent thinking, to answer a few of the questions usually expressed by How and Why? Now biology is preeminently fitted to produce just these results, for the student, because he has to answer how and why over and over again in the laboratory, in explaining the similarities and differences that exist between the several organisms that he is investigating. I say investigating, because his work should be so directed that each new organism is individually studied. This implies that the student shall do some work for himself and not identify described parts, or what is worse copy drawings from books and charts and take down dictations from the teacher with the idea that this is doing laboratory work.

Culture stands in sharp contrast with superficial acquirements; it is like the oiling and polishing of wood which brings out the grain; while painting, the superficial, covers the surface, conceals the grain entirely or represents a false one. Many fine pieces of old furniture have been ruined by painting. Culture is not alone a product either of the intellectual ability, or the moral standard, or the esthetic sense of a person, but rather the quality of each. In determining how biology contributes to culture through these

three main avenues, we must briefly make plain our understanding of these terms.

Let us for the sake of discussion, accept as a definition of culture, openness of mind; then we must necessarily ask in considering moral culture, this question, what is moral openness of mind? We gather some idea of a man's moral nature by his actions. We are here concerned only with the highest expression of this character. He who shows an appreciation and reverence for laws higher than those on the statute books has a desire for the noblest and best, which is an expression of his moral nature. Now if this same mind is open to receive facts of any sort, and is anxious to place them in their proper relations and to give to them their correct values, there then exists moral openness of mind.

How does biology contribute to moral openness of mind? That is, how does it contribute first to information and secondly and fundamentally to an anxiety to place facts in their true relationships? Of the different ways in which biology is of value in moral culture, we may mention the observance of law as one of the most important. For example in the study of the amoeba, the student may easily be brought to realize that not only fulness of life but actual existence is absolutely dependent on certain conditions such as moisture, food, and temperature. Fail to fulfil one of these conditions and lowered vitality or even death results. Here we have one of the simplest expressions of life yet in this but slightly differentiated mass of protoplasm, the student has presented to him most forcibly the impossibility of disobedience to higher laws.

Another phase of this same question is presented in the interdependence of all living organisms. The observations of many centuries have failed to establish a single example of spontaneous generation but they have repeatedly proved that life proceeds from life, that each individual is not alone dependent on a given environment for the continuance of life but is directly dependent on his fellows for the origin of individual existence. This naturally results in a study of reproduction in plants and animals which must present the importance and necessity of the process. Under

the tuition of a high-minded instructor, there can hardly be established an ideal more wholesome and more sacred than that commonly found in the average young person.

After the student has acquired a conception of the higher laws and the mutual interdependence of all organisms, he is in possession of information that appeals to a deeper feeling than mere interest, and which impels him to stop and ponder. If he can get at the real significance of these and similar facts, it seems to us that he will be led to ask the question, whence come these laws and relationships? The conclusion that must inevitably follow is that they are an expression of God in nature.

Permit me again to state our definition of culture as openness of mind, this time to consider intellectual openness of mind. By intellect we mean ability to do independent thinking, not that we fail to recognize the psychologic constituents of intellect such as the sensations, perceptions, apperceptions, etc., and their importance in the growing mind, but what we are looking for is active intellect and that is power to think independently. He who can not do this is a slave and must forever remain such. To handle new and difficult problems, to place them in their proper relationships, and to sense correctly great movements, is an indication of one's intellectual ability and can result only from openness of mind: This is the characteristic of the mind that contributes to one's vocation. By this he is enabled to gain a livelihood; and because of this fact, it is the characteristic on which most stress is ordinarily placed. In short, information from which conclusions can be drawn and the power of critical observation which implies ability to estimate the relative value of facts, are the two main essentials to independent thinking.

When several people witness an event, no two see the same things or are able to present the same description. This may be taken as an example of general observation which differs greatly from detailed or critical observation. Biology furnishes the best of training in this second kind of observation. The student is given an organism to study, this is followed by a related organism and he is asked to note the similarities and differences existing

between the two; and not only to compare but to explain them. This necessitates some thinking. Usually an opportunity is given for each student to state his explanations and some are asked to give their opinions. By this process the relative value of different facts is brought into consideration and there results an ability to estimate properly these different facts. How much importance does one set of facts have and should a second set be logically considered first or second in its bearing on the changes involved, are questions that are continually arising.

Nearly every one knows something about the changes incident in the transformation from the egg to the adult in the frog. The tadpole is so abundant that every boy in the country and small town and many in the cities are perfectly familiar with it. Many do notice that the limbs appear and that the tail is lost, but how many notice the order in which the limbs appear or the manner in which the tail is lost? If the tail should be removed artificially, is there any effect on the formation of the limbs, in other words are the appearance of the limbs and the absorption of the tail in any way correlated? Even such observations as these are more or less general and one of the teacher's difficulties is to secure exactness in the study of gross objects. But when the student begins microscopic work, the observations become more exact, the attention being definitely placed on one object which explains in part why students find beginning microscopic study so difficult.

I further believe that the greatest good is not secured from these observations and the drawing of correct conclusions unless the student be required to record them in a suitable notebook. After six years of examining secondary school notebooks the conclusion is forced on me that this phase of the work is not inspired by a sufficiently high ideal. It is not necessary that an expensive notebook be used but it is important that there be uniformity in a given class and a definite method in recording observations and making drawings. There can be but little pride in a book hastily made and with no fixed system. This phase of the training is an important one because here the student may learn to express him-

self in a clear and logical manner acquiring thereby to some extent at least a "certain amount of ease and elegance in writing."

Biology contributes moreover, to a broadening and clearing of the intellectual horizon in the character of the information presented which may also serve as an admirable background upon which we may study many of the modern questions. Take for example the fact that we have so many patent medicines, warranted to cure all aches and pains; also the large number of quack doctors who would not be in existence, if they were not making money. Now it occasionally happens that fake practitioners have well informed people for their victims but in the main it is the more ignorant class. We may well ask the question why this condition should exist. The answer is found in the following facts: comparatively few people know the real cause of disease, it is all more or less of a mystery to them and one fakir with a glib tongue and perfect assurance using a pseudoscientific mode of expression. forces conviction on the uncertain mind of the listener. So we find many strange views abroad concerning consumption and its supposed transmission from parent to offspring, while nearly every newspaper contains an advertisement guaranteeing to cure it. Similar crudities exist in regard to most of the common diseases. A general course in biology may very properly, while treating of bacteria, discuss their relation to disease. We believe that this would materially assist in establishing a saner appreciation of the laws controlling our own bodies and give to the well trained physician rather than to the fakir the remedying of disease.

If for the sake of further discussion, we accept our provisional definition of culture as openness of mind, the question now arises, what is esthetic openness of mind?

A proper attitude of the esthetic sense is difficult and unnecessary to define in detail, in general we may state these essential points. A cultivated esthetic sense unconsciously shudders at a lack of harmony in anything. The artist instinctively feels the slightest error in tone or coloring; but even the untrained esthetic

sense is moved by the power of music, the perfection of a good picture, or the innate beauty of nature itself.

In proportion as a man's mind is open to the details of the beautiful and consequently more or less able to place them in their proper relations, in this same degree has he esthetic culture. At first thought this may seem to be untrue, for fundamentally the esthetic sense has to do quite as much with the emotions and the imagination as with the intellect, but on second thought one realizes that it is the man open to the details of the beautiful, and responsive to them whose emotions and imagination are so developed and stimulated that his attitude is one of sane appreciation rather than one of blind ecstacy.

My thoughts in regard to the beautiful in nature are best expressed in the following lines from Wordsworth.

> For I have learned
> To look on nature, not as in the hour
> Of thoughtless youth; but hearing oftentimes
> The still sad music of humanity...
> And I have felt
> A presence that disturbs me with a joy
> Of elevated thoughts; a sense interfused,
> Whose dwelling is the light of setting suns,
> And the round ocean and the living air,
> And the blue sky, and in the mind of man:
> Therefore am I still
> A lover of the meadows and the woods,
> And mountains; and all that we behold
> From this green earth; of all the mighty world
> Of eye and ear...
> Well pleased to recognize
> In nature and the language of the sense,
> The anchor of my purest thoughts..."

One student is born with more, another with less of the esthetic sense but it is possible to develop in both a large measure of appreciation of the beautiful. Biology does it in two ways: either the student sees in nature something beautiful which creates an interest that leads him to the laboratory where a detailed study brings him to a full appreciation of what already appealed to him or else having begun the study of biology for more utilitarian reasons, the laboratory study and the excursions into the fields and

woods call to his attention and make plain beauties heretofore hidden or slighted; in either instance, it is not long before he is observing nature "with an eye made quiet by the power of harmony."

In illustrating how the esthetic sense may be cultivated by contact with nature two examples only will be given; many more might be cited.

The common humblebee while busily securing his food from the flowers performs a very important, yes, essential work for the lady slipper orchid, cypripedium. As he crawls between the lips of this flower after the honeyed solution produced for him, he finds that he can not escape by the same way that he came, but in order to gain his freedom must pass out past the pollen masses and the stigma. This opening is so arranged in relation to these structures that the bee's back comes in contact with them; if the bee has been to another cypripedium, cross fertilization is thus effected. This exchange of pollen is necessary to insure fertility to the orchid, though accomplished by the bee unconsciously yet so certain is it that the bee will visit the lady slipper that this is the only method of cross fertilization. Both of these organisms are beautiful in their coloring and their habits, but when we learn of the interdependence of each we have an added factor of interest which contributes in several different ways to the idea of esthetic harmony in nature.

Nearly every one knows the names of a few birds; their colors and songs appeal to our sense of the beautiful. But when we have only a speaking acquaintance with them, they do not contribute much to our happiness.

During the past summer I had occasion to spend a number of weeks in the Adirondacks, the nesting home of some of our choice birds. Here I saw them at home and became quite familiar with their love calls. The timid and shy bird of the city seems to have no fear of a man there. On many an evening our party sat and listened to the sweet singing of a family of hermit thrushes which nested in a tree near our camp. As the young ones matured and left their nest they, too, began to sing and we learned to distin-

guish the song of the parents from that of the young thrushes, one of which had a clear flutelike tone of great sweetness, specially was this so when the wind was moaning low in the solitude of the forest.

And there were several families of teacher birds too, which as you know hide their nests in the leaves on the ground. I spent many delightful hours trying to find one and all the time my imagination was forming pictures of where the nest would be, how it would look, and wondering if there would be any young fledglings in it. I was looking for the details of the beautiful in nature. I found them, though I never succeeded in my original quest.

"What we do see," says Lubbock, "depends mainly on what we look for. When we turn our eyes to the sky, it is in most cases merely to see whether it is likely to rain. In the same field the farmer will notice the crop, the geologist the fossils, botanists the flowers, artists the coloring, sportsmen the cover for game... We speak of the pleasure which nature and art and music give us; what we really mean is that our whole being is quickened by the uplifting of the veil. Something passes into us which makes our sorrows more sorrowful, our joys more joyful, our whole life more vivid."

Gertrude S. Burlingham—The subjects of the high school curriculum can be divided into about three groups; the first including the ones studied chiefly for their practical value, the second those which will develop the brain as a working mechanism but may be of very little practical use, and the third, the subjects which will bring the student into a knowledge of the world about him. In this class we may place history, literature, and natural science. To this group more than the others we may apply the term cultural studies. And after listening to Professor Smallwood's paper, I think we will agree that among these, biology ranks by no means least.

One possesses culture in proportion as he is in touch with the life about him. Biology is the only subject among the high school studies, which brings the student into direct contact with the life

of which he is a part. Ideally, he should feel that he is studying at the fountain head; that whether the object for his consideration be an alga or a restless, cheery chickadee, he is studying not an opinion or an hypothesis, but a perfected handiwork, which, had it been less perfect, nature would not have preserved as that living type. When one approaches the study in this way, the mind is immediately open. And on the intellectual side, he finds himself gleaning a stock of information, without which, it is coming to be, one can not lay claim to a broad culture. At the same time, he is forming an acquaintance with living things with which he finds he has much in common, till he begins to draw for himself natural laws, not only in the spiritual, but in the social world.

Literature is man's effort to put nature and life into words. History is life studied secondhand and at a distance, and nature and art are inseparable. Thus biology is not merely a cultural study in itself, but it opens the mind to an appreciation of the best in literature and art, and lends a new meaning to history.

As an illustration of the fact that the study of biology does enrich the individual life, there comes to my mind the case of two young women, graduates of the same college and high school, living on the same street in a certain city. The one who had no training in biology, found herself the year after graduation, with time hanging heavily on her hands. In the midst of one of the richest bits of nature, she lived with eyes closed to the beauty of hills and forests, with ears deaf to the call of the birds—a stranger to the great world of out-of-doors. The other bade good speed to the junco, gathered arbutus to the song of the field sparrow, found where the rarest flowers bloomed. To her

> The meanest flower that blows can give,
> Thoughts that do often lie too deep for tears.

To the former, a primrose was—a primrose. The outlook of one was broad and rich, of the other, restricted and impoverished. Biology had given the one a power of independent work in a field which will ever be to her a source of enjoyment and growth.

Students, even in the last year of high school work, begin the study of biology with very little power to do independent work

and careful thinking. They are unable to draw conclusions from a series of facts unless they have already studied physics or chemistry. The student has dealt mostly with textbooks, and does not know that he has the latent ability to gather facts for himself, that it is his privilege to collect knowledge first-hand and to do his own thinking. The mind easily becomes inert. Students, as a rule, dislike to think. They prefer to have some one think for them. Sometimes it is the textbook which fulfils this function; again it is another student; sometimes the teacher is led to do his thinking. Biology, properly taught, will make the student do his own thinking, and more than that, he will grow to like to think for himself. The testimony of students is often of great value, since they are in a position to know many things which a teacher does not know.

A young woman who graduated from the classical course in a certain well known high school, at the head of a class of seventy returned, for a little further work, including botany. At the close of the term she said that that was the first work which she had taken in high school, in which a student could not get some one to do his work and thinking for him. It may be well to state that she had taken no other laboratory science work. Laboratory work in biology means independent, individual work, the arranging of facts and forming proper conclusions.

Next to thinking, perhaps most high school students dislike accuracy. It is so much easier to say very small or very many, than to give exact size and number. The study of biology ought to develop a love of accuracy—this is one of the fundamental requirements in making a laboratory notebook. The drawings must be true to life and the written work accurate in statement. The making of a good notebook is in itself an intellectual, moral and esthetic culture. At the same time it is a very practical help in the ability to express thoughts in good English. The student becomes a producer of one form of English.

Children are naturally acute observers. But often by the time they reach the second year of high school, this power has become lost through disuse. Nature study will undoubtedly tend to

obviate this condition. But if this is not so, the study of biology should restore this power of observation and educate it. The faculty of quick and accurate observation is certainly "openness of mind."

That biology is a valuable cultural study can not be denied. How can it best accomplish the desired results? First it must be taught in such a way that the student will be brought into an intimate, sympathetic relation with nature, into a position where nature can speak to him, and in which he can interpret her messages. Again the laboratory and class work must be so conducted as to make other than original, independent work impossible. It must develop an appreciation and love of accuracy. The field and laboratory work should educate in the student the power of quick and accurate observation. And lastly, the study of biology should act in the mind as a ferment which time can not kill, so that the mind will be stimulated to reach out for more knowledge at each opportunity till, little by little, it attains more nearly the standard of a perfect culture.

EXHIBITION OF A DECEREBRIZED FROG

BY BURT G. WILDER, CORNELL UNIVERSITY

Prof. Burt G. Wilder of Cornell University exhibited a living frog that was decerebrized Dec. 4, 1899, four years ago. Since that date, excepting slight occasional shiftings of the limbs, as if from muscular ennui, it has manifested neither consciousness nor volition, and has to be fed by placing bits of meat or fish well down the throat within reach of the reflex mechanism of swallowing. Nevertheless it leaps when touched, turns over when placed on the back, swims till a support is found, and balances itself on a slowly revolving cylinder. From this last manifestation of powers evidently residing elsewhere than in the cerebrum, and in honor of the German physiologist who first called attention to it, a frog so operated on is known as "Goltz's balancing frog." For many years such a frog has been shown to the classes in physiology at Cornell, but never before, so far as the speaker knows, has one been kept alive so long.[1]

[1] September 1904 the frog was alive and apparently in good condition.

The animal is etherized, a part of the skin on the top of the head turned off as a flap, and a bit of the cranium removed; with sharp scissors the brain is transected at the diencephal (region of the thalami) and the cerebral hemispheres and olfactory bulbs wholly removed. In this connection Professor Wilder stated that, from the opening of the University, in his department, all experiments that might be painful had been performed on animals either just killed or fully anesthetized.

Section C. EARTH SCIENCE

TEXTBOOKS IN GEOGRAPHY

BY MARGARET KEIVER SMITH, NEW PALTZ NORMAL SCHOOL

Ages ago, a certain writer, in a discouraged mood, despairingly declared his convictions regarding the endlessness of bookmaking, and the weariness resulting from the study of books. If these were his sentiments at a time in the world's history when books were a rarity, and study was limited to the leisured few, what would the wise man say today, when books are in numbers as the sands of the sea, and when the weariness of study is imposed upon every child of Adam that can lay the slightest claim to civilization?

From the association of books with study, and the mention of the consequent weariness to the flesh, we take it that the wise man was not inexperienced in the matter of textbooks, though not for a moment should we think of ascribing his reputed wisdom to this source.

Universal as they are, and indispensable as we admit them to be, no one under any circumstances assumes that wisdom is to be achieved through the use of textbooks. As a rule neither knowledge nor wisdom is to be found between the covers of a book, text or otherwise. If, bringing a good natural intelligence to bear on the matter contained therein, the student find anything that shall develop this intelligence and aid in forming significant thought, he is fortunate indeed.

In itself, no book is an end. Often it is a very poor means toward the attainment of an end. Without an understanding of

its use and possibilities, it is a great hindrance to intellectual development. The time has gone by when a great reader, a devourer of books, a bookworm, was regarded as a man of wisdom. Even the man of one book, against whom we are warned, unless his knowledge be supplemented by experience, is regarded with uncertainty, and even suspicion. The test of wisdom is not that which a man takes into his mind, but that which he brings to pass by reason of that which he has taken in.

The individual who reads much is in danger of becoming a very lazy person. It is so easy to sit still, and see the beliefs of an author reflected in one's mind as in a mirror; and it is so pleasant to assume that since one recognizes them, one understands them; and from this condition, one may easily attain to the conviction that one originated them, or could do so, if one were so disposed.

And yet books, even textbooks are a necessity. Make such objections as we may, we must perhaps admit that even a poor textbook is better than none at all. Taken at its worth, its mission is still beneficent, inasmuch as it can at any rate show us how not to do it.

There is but little danger that even a bookworm will ever become a devourer of textbooks. The dislike to a work of this kind is too instinctive, and the tendency to judge the author unfavorably is too strong. The poor author! Gratitude to any author is hardly a mark of any reader, but probably no writer performs a more thankless task than he who writes a textbook.

Carlyle said, and the world has echoed the sentiment, that probably once in 200 years a man is born who is fit to write a book; but no one accepts the volume as a textbook. Indeed it would not surprise us to learn that the man who is fit to write a textbook has not yet been born. There are good books in the world, but is there a good textbook?

"Yes," says the author, "a book that presents a comprehensive and scholarly treatment of a subject, and at the same time, adapts that treatment to the apprehension of the immature mind, throughout providing for the mechanic side of learning, in the way of summary, reproduction and drill—that is a good text-

book." "Yes," says the energetic publisher, "a textbook that goes off directly after publication forty or fifty thousand dollars worth, and keeps that up yearly, say for 10 years, that is a very good textbook. But a book that dawdles at the first moment will never do more than pay expenses, and, though a Solomon may have written it, it isn't a good textbook. It is not the textbook that the public needs. The money value is a very good standard in the matter of textbooks."

We know of more ways than one of starting a new textbook on its career, so that the pleasant figures just quoted may be reached at a bound, and we know of more ways than one for giving this book momentum sufficient to keep it going for, say, 10 years. In all these ways Solomon may or may not have a part, but notwithstanding the wisdom of Solomon, and energy of the publisher, the most successful textbook leads a doomed life, and has an assured fate, viz, in the near future to find a resting place on the top shelves of some dark closet; or to become a part of the refuse lumber of some dusty attic. If by accident we come on it, we turn away to avoid the memory of painful and tedious experiences with that book, and with teachers who demanded for it a certain interpretation and tolerated no other. Those were dark days, and were better left to the dimness of the attic.

If we desire information on any subject, we seek it anywhere rather than between the covers of a textbook. Something in the very aspect of the volume brands it with the charge of inadequacy. This is true of textbooks in general, but of textbooks in geography it is specially true. We are even a trifle prejudiced against the size and form of this book. It is unpleasantly suggestive of the weighty pyramid of school lore which the pale girl rears on its broad, flat base, and which supported by insufficient arm and hip, she bears unwillingly to school.

Writers of present day textbooks in geography make a merit of changing its unwieldy shape, so that the geography text of the public school is coming to assume the bulky proportions of the school history, or indeed, of any other volume of the pile.

The textbook in geography of the past had a somewhat limited purpose. It was intended to furnish a certain amount of information—mathematical, physical, and political—concerning the earth. This information was set forth in a series of definitions and descriptions, together with a catalogue of divisions of land and water, to which was appended a brief historical account of life, vegetable and animal, and of the names of the races of man on the earth.

From the standpoint of this manual, the earth had no past and no future. As it was, it might have sprung into being in a night, and, as it was, might be destined as suddenly to pass away.

The definitions of the book were totally independent of one another, and were generalizations on the basis of no known particular. The pupil's work was to learn the volume verbatim. The result was that, after an extended course, an individual might know the book from cover to cover, and not realize that the matter contained therein bore any relation whatever to the earth on which he lived.

The cities of the world were not in the world, but in the book, and after long familiarity with them in the latter location, later in life one was startled to discover that the real world and the book world were quite different existences, and that familiarity with the book world did not by any means imply a working knowledge of the real world.

As a commendable point, it may be mentioned that the definitions really defined, and that the descriptions were usually expressed in concise and significant language.

The map studies dealt entirely with locations, but they located nothing outside the map. The map was the real thing and the reason for its existence was not always apparent. Stories are told of children who while reciting matter concerning the earth, declared that they never had seen the earth nor any part of it. The same children were known to state the definition of an ocean, and in the face of the Atlantic, not a mile away, to declare that they had never seen an ocean except in the patch of blue on the

map. Europe was a patch of red, Asia yellow, and Africa more or less brown.

The relation of the map to the earth was seldom if ever mentioned. The vigor with which the teacher insisted that the book should be learned verbatim imparted to the text a character of reality and finality which made it seem the end and aim of all effort.

Perhaps it is not too much to say that, except in individual cases, no real geographic knowledge was gained from the textbook.

One learned to know countries and cities and people from reading stories, travels, history, poetry, and from hearing one's elders discuss the contents of newspapers; but one never thought of mentioning such things in connection with the geography lesson.

The textbook that furnished such inadequate instruction, while possibly better than none, was very undesirable, and with advancing intelligence concerning the significance of instruction, a reform became an absolute necessity. The textbook, having nothing to do with the child's actual experience furnished no knowledge, and worse still, aroused no interest on the part of the learner.

In order to find a reason for the arbitrary work in connection with the old textbook, which I fear has not yet entirely disappeared, it may be necessary to go back a little to find just how geography ever became a subject of instruction in the common schools.

The first mention of geography in this country is by Comenius somewhere near the middle of the 17th century. The step taken by Comenius seems to have been due to suggestions by Lord Bacon of England. Bacon made no plea for the study of geography as such in the schools, but he urged strenuously the necessity for teaching the real things of the world, rather than the traditions of things.

For the first instruction in geography, Comenius proposed to do the work without any textbook whatever. In the early work

in the first department of school life (children from 4 to 6 years), the pupils were to become familiar by actual observation, with a hill, a valley, a field, a brook or river, a lake or pond, a village or town, a city, etc. They should know the sun, its rising and setting, the moon, its rising and going down, and the stars, together with the names of a few special ones. In the next department (children from 6 to 14 years), the pupils should learn the curve of the heavens, the spheric form of the earth, the movement of the ocean, the crooks and turns of a river, the divisions of the earth, the principal kingdoms of Europe, and the cities, rivers, and mountains of their own countries.

All this was to be learned from observation, inference, conversation and reading.

In the advanced department, or latin school (pupils from 14 to 18 years), students should study geography scientifically. They should be furnished with excellent textbooks, maps, charts and apparatus. They should learn land and water forms, atmospheric phenomena, political relations between countries, etc.

The aim of Comenius was to secure accurate knowledge of real things, on which he might later arrange a system of scientific generalizations, which, in their turn, should serve as a foundation for philosophic thinking.

Probably, since the time of Comenius, no better scheme of instruction has been conceived, and the wonder is that it has not been more closely followed. We may observe that in it, the textbook only comes into use in the highest department of the school, and that it is a textbook fitted for scientific work.

John Locke, a contemporary of Comenius, was instrumental in introducing geography into the schools of England; but his plan of instruction was such as to defeat the very end he had in view. He advocated the learning verbatim of facts expressed in a textbook and on maps. Probably he never discovered that geographic generalizations memorized without any knowledge of the underlying ideas furnished no more real knowledge than did memorized grammar and history.

Locke's influence on the teaching of geography in England lasted for at least 200 years, probably in some parts of the kingdom it is yet active.

The custom of learning the textbook verbatim was brought to America perhaps by the Pilgrim Fathers, and up to 1860, at least, it was practised in all the schools.

As the textbook always stood between the teacher and the pupil, it is no matter for wonder that the child was lost sight of, and that quite unconsciously the powers of the adult came to be attributed to the infant. The failure to recognize the difference between the child mind, and the adult mind seems always to arise in cases of excessive textbook work.

The influence of the Pestalozzian work done at Oswego in the sixties and seventies; Guyot's visit to America and his lectures in Lowell Mass.; the publication of Humboldt's *Cosmos,* together with the translation of Ritter's *Comparative Geography,* and (perhaps more than all) the development of the theory of evolution, brought about a positive reaction against the finality of the old textbook. Before referring to our textbooks as they are at present, it may be well to mention several significant points which ought to have some influence in determining the character of our textbooks in the future.

1 The development of geography as a science out in the world is very much in advance of the development of geography as a subject of instruction in the schools.

2 People who are pursuing geography zealously out in the world do not seem to attach any importance to the work done in this subject by our public school teachers. Much less would they think of referring to any one of our textbooks in geography for any important geographic item.

3 It is a question whether many, perhaps whether any of our public school teachers of this subject could achieve a membership in any important geographic society in this country or abroad.

The reason for the difference between geography out in the world, and in the schoolroom lies largely perhaps in the difference between the aim of work in the world, and the aim of work in the schoolroom.

The causes that have led to the acquisition of geographic knowledge out in the world, have, many of them, been at work since the beginning of civilization. As civilization has advanced, new reasons for the pursuit of knowledge of the earth have arisen and have become so prominent that the study of the earth on which we live has become more imperative than any other study, so that just at present, our teachers are overwhelmed with the multiplicity of subjects which zealous people assure us come under the head of geography.

Some of the more important causes for the acquisition of geographic knowledge are

1 The wandering instinct, the love of adventure and discovery for its own sake.

2 War and conquest. Here for purposes of offense and defense, geographic knowledge has always been an absolute necessity.

3 Colonization, religious zeal, pilgrimages, crusades, missionary work have all been at the bottom of the acquisition of geographic knowledge by people interested in these directions.

4 Desire for knowledge for its own sake has always been alive in the world, and has always kept man working on the great problem of the earth with a view to satisfying human curiosity concerning the beginning and the end of the world.

5 The very strongest impulse towards the study of geography, however, has been and still is that of commerce, which takes into consideration all phases of life, and all geographic considerations through which life can be improved and perfected.

Among the later influences on this subject may be mentioned the development of science in every department of civilized life. Through photography alone, the increase of pictures of foreign countries has been a great incentive to travel, so that people now flock to the ends of the earth to experience changes in climate, to look on mountains, to learn the beauties of rivers and lakes. These desires for the experience of something new have given a tremendous impulse to the study of guidebooks, maps, and books of travel.

In addition to the influences just mentioned, the recent polar expeditions, and the results of the surveys of countries that are now being carried on are doing much to increase the interest in geographic study.

In comparison with the interest and activity out in the world, our interest and our results in connection with schoolroom geography appear to be very feeble and ineffective. Whether the function of the school be to impart to the children the knowledge that has been gained outside, or to prepare the individual to appropriate and apply that knowledge that awaits him when he goes out into the world, we must acknowledge that our success in the matter of geography, up to the present time has been very limited.

While we can not perhaps bring into the school the aims and interest which direct the best efforts of mankind in the world, our work ought to be of such a character as to make the attainment of practical ends later more possible and less difficult than they are at present.

Geographic literature, as we find it in books of travel, history, science, and the leading periodicals, besides having a great commerical significance, is not without a very important culture value.

Textbook geography as it is arranged, has little if any commercial significance, and up to the last year or two, its culture value has been imperceptible. The activity in connection with geography in the world outside has exerted some influence on our textbooks, but as yet, the results are not all favorable.

We have found that the phenomena of life on the earth are geographically determined, but for the most part, we have failed to distinguish between the result determined by geography, and the geographic phenomena themselves. Owing to the failure to distinguish between cause and effect, much material has been brought into the textbook which really does not belong there, and which prevents a scientific treatment of the subject.

Another reason for swelling the textbook to undesirable proportions lies in the effort that has been made to render the study

of geography a means of intellectual development second to no other. To this end the "causal relation" and the "human interest" have both claimed a place in the book.

In order to work out the causal relation, however, no inconsiderable knowledge of mathematics, physics, geology, astronomy, botany, and other related sciences, is necessary. In the attempt to impart this knowledge incidentally, the text has become laden with collateral material which textbook makers themselves admit is not geography, but which they assert must be learned before geography can be understood. This last statement is true, but textbook makers should understand that such subjects can not be understood through such fragmentary items as are here and there presented in connection with geography.

This extraneous material has not been properly subordinated to the purpose which it is intended to serve; hence the voluminous and confused character of many of our present textbooks in geography. The understanding of the explanatory subjects is often more difficult than is the understanding of the subject which they explain.

The work on the "life interest" is no less extensive than that on the causal relation, and involves the insertion of a vast amount of matter that has not yet been subordinated to its purpose.

Owing to the fragmentary and varied character of the explanatory or illustrative material, a systematic management of the text is difficult, and at times impossible.

The result is that in the majority of our present day textbooks we have a mass of matter that is not recognized by any well established geographic society in the world.

In many cases, textbook writers themselves are but little scientific in their habits of thinking and writing; hence do not know how to subordinate unimportant points to those absolutely essential to the apprehension of a subject. The nature of the child, and the nature of geography as a science, seem to be equally foreign to them.

Another cause of inadequacy is that many of our textbooks are constructed to fit the limitations of teachers. Sometimes the

text seems to be prepared with a view to what the teacher can not teach. Within the last few months, the writer has been told by both publishers and textbook makers that if the textbooks were scientific, the teachers could not use them. This appears to be a most significant comment, and ought to arouse attention to the character of the teaching in our public schools. At the same time, it may be said that even a poor teacher is much more liable to develop power from the use of a well prepared scholarly textbook, than from the use of a carelessly arranged inaccurate one.

Another weakness to be met with is, that the writer in his endeavor to arouse the interest of the child by meeting him on his own ground instead of being merely simple and easy of apprehension, becomes inaccurate, unscholarly and misleading.

Another difficulty in the way of our obtaining thoroughly good textbooks lies in the lack of standards for comparison. We seem to have few if any best books. One book is as good as another on the whole, so that our books enjoy an unenviable mediocrity.

Still another hindrance exists in the unclassified, ungraded character of our textbooks in geography. The same text is sometimes used for the grammar grades, the high school, the normal school, and even the college.

When this is the case, the book must either be above the intelligence of the children of the grammar grades, or below the mental capacity of the high school, normal school, or college student and, therefore, the work with it must be more or less ineffective.

If time permit, a word must be said concerning the method of presentation as indicated by the textbook.

The concentric method appears to meet the approval of some writers, and, if the principles of this plan were strictly adhered to, the results might perhaps compare favorably with those of other methods. With some writers this method seems to imply a partial repetition of topics at irregular intervals. We have heard of one book in which astronomy is treated in 13 different places; meteorology appears in 21 places; geology is touched on in 29 different places; anthropology in 19 places; industry and

occupations occur in 30 places. This presentation of disconnected items from the same subject can hardly fail to exert an injurious influence upon the child's continuity of thought and must go far to destroy unity of intellect.

As regards the construction of a textbook that will be a help to instruction in geography we should first consider the degree of development that will warrant the use of a textbook by children.

Till a certain experience is gained, and a certain amount of knowledge is acquired, the generalizations of a well prepared textbook must be meaningless to the child. To put him in possession of this necessary experience and knowledge, a certain phase of instruction, known as home geography, has been arranged. While the efforts in this connection have been and are commendable, the results as yet are not entirely satisfactory. As a matter of fact, children care comparatively little for the phenomena of land, water and air in themselves. Neither do they care for man's industries to any great degree. The beauties of nature as such, or the adaptation of organisms to their uses do not specially impress them. They do care, however, for the life interest, and specially for all manifestations of human beings. Human activity, however, as manifested in the phases in which children do care for it, is not exactly the matter of geography, and therefore has hardly a legitimate place in the textbook.

By all means, let the life interest have a very prominent place in early education, but let it be what it is—not geography, though it is a very excellent preparation for geography. The life interest can not be met by a textbook, but it can be met by stories, conversation, and reading books.

The utmost care should be given to the selection and grading of the material: stories of people about us; stories of people far away; fables; myths; heroic stories; historic stories; books of adventure; books of travel; books of discovery; poetry of a narrative kind.

This material should be carefully graded according to the advancement of the children. Because of their culture value,

these stories should be of the best, and should be such as are written by masters, not adapted by uneducated girls, or by women who claim some feeble literary learning.

In connection with this work maps should be used. By means of them scenes and characters of stories should acquire local habitations. Land and water forms, climate, soil, altitude should receive constant reference as determining conditions of action.

The play of the elements should be utilized in enhancing the difficulties or favoring the performances of favorite heroes.

In this way the elements of geographic knowledge, being quickened by human life, acquire an interest which geographic study of itself could never arouse.

By the time that children are ready for the high school they should possess a fund of material that will enable them to understand the generalizations of the textbook in geography.

The textbook for pupils thus trained must of necessity be scientific in thought, and scholarly in expression. It ought to be the best effort of a geographer, and of a man of letters.

The general textbook in geography prepared for the high school might include perhaps four different subjects.

Under the first should come the consideration of the earth in its individual existence, and in its relations to the sun, and to the other planets.

The treatment of this part of geography seems to be omitted more and more, the space being devoted to the discussion of physical geography.

As a matter of fact without a somewhat full treatment of astronomical geography, physical geography can be but imperfectly understood.

In the first division of the book, the representative character which distinguishes geography from every other science should be fully and clearly presented. The omission of this has been the cause of much confusion as to what really constitutes geography as a science. By depending too much on the other sciences of the earth, e. g. geology, the development of geography is greatly delayed.

Within the first division also may come a presentation of the principles underlying the changes taking place in the surface of the earth. Also the relations of continental structure, the formation of islands, and the courses of rivers. All these should receive more careful treatment than has yet been given them.

The second division of the textbook ought to give more advanced work on atmospheric phenomena with a view to making climate (perhaps the greatest influence determining man's development) more generally intelligible.

The textbook in this connection should provide for a kind of laboratory work by means of which local phenomena of the sun, clouds, wind, temperature, precipitation, and so on, might be observed as influences largely determining the weather and climate of a locality. In addition to this, the influences of the distribution and structure of the land and water forms of the earth on climate should be treated.

After a careful presentation of the first and second subjects, there should come the third, namely, the treatment of the geographic determination of the development and distribution of plant and animal life.

The confused treatment of this topic in many of our textbooks, often leaves one uncertain whether one may not be studying botany or zoology quite apart from geography.

The fact that all manifestations of life are geographically conditioned, should be very clearly presented. It is so vaguely apprehended that much of the work in this connection is practically valueless, either as a means of knowledge or as a means of intellectual development. The work in this division is not entirely geographic. It is rather an application of the principles of the first two divisions.

The fourth and last division of the textbook might very profitably be devoted to a second application of the principles of the first two divisions, viz, to the distribution of races on the earth, and to the geographic determination of man's activity. Owing to lack of understanding of geographic laws, these determinations have not yet been adequately worked out.

Man's activity as manifested in his industry, government, art, social customs, religion, and philosophy is either remotely or closely related to climate, location, and other earth influences; and an adequate understanding of these influences on man's activity would do much to furnish a clearer view of humanity as a whole.

As in the preceding step this work is historical rather than geographic, but a careful consideration of conditions and their results will do much to broaden one's apprehension of what one already knows.

In addition to the textbook for students, there should be textbooks for teachers. The teacher should study something beyond that which is prepared for pupils. He can, it is true, get much from general reading, but often he has neither the time nor the strength to arrange the matter of general literature into the best form for presentation in a classroom.

Because of the lack of textbooks arranged from the teacher's point of view, the work in normal schools seems to be greatly hindered. In some schools, the same text is studied both by the teachers in training, and the pupils in the practice school. This appears to be one means of keeping the young teacher down to the level of her pupils!

We should have working textbooks in geography constructed on the laboratory plan of textbooks in chemistry and physics.

Textbooks in what we call historical geography, military geography, commercial geography, can hardly be regarded as real textbooks in geography. They are historical in their character, and are intended to show how history, war, and commerce have been and are determined by geographic conditions. Without a clear understanding of this fact their use may be a means of delaying the development of geographic knowledge. They should be studied after the principles of geography have been learned.

Tuesday morning

GENERAL SESSION

CHEMISTRY IN THE HIGH SCHOOL

BY E. G. MERRITT, LAFAYETTE HIGH SCHOOL, BUFFALO

In view of the progress made in educational ideas during the past quarter of a century it is needless for us to present arguments in favor of science teaching in secondary schools. The increasing demand for science courses in our high schools is an evidence of the recognition of their practical and educational value.

Though science has, after a long struggle, secured a permanent place in the curriculum, its opponents still question its value as a means of discipline when compared with the classics. This view is often made evident by the objections that are made to the granting of the B. A. degree to graduates from science courses.

It seems to me that, of all the sciences, none touches the pupil at more points or is more closely related with human needs and the ability to supply them, than chemistry. To make claim to liberal education one should know something of the composition of the earth on which he lives and of the water and air that envelop it; of the food which sustains his life and the principles of nutrition; of the known elements and some of their general properties; of the more important technical operations in which chemistry is involved, such as the manufacture of iron and steel, sugar, glass, leather and many other similar processes. Why be up on ancient history and heathen mythology and confess absolute ignorance of facts that concern us so vitally?

Admitting the demands of chemistry to a place in the high school course, what portion of the subject shall be taught and what shall be the method of presentation?

The course in chemistry usually begins with a part which is intended to be introductory and is not considered a portion of the systematic presentation of the subject. Here an attempt is made to bring the attention of the pupil to the various types of chemical change, the characteristics of chemical action and the

habits he should form and the methods he should adopt in doing chemical work.

The elementary study should begin with the more familiar forms of matter and familiar phenomena should be selected. Unfamiliar facts must, at first, be closely related to those which are familiar. To the beginner chemistry is a strange subject, dealing almost entirely with unfamiliar materials, and it can never be made interesting to the majority of pupils till it becomes related to those facts which are familiar, or till it is given a tinge of human interest. We should not build a high fence around our subject that will shut off all view of the world outside and its chemistry, but on the other hand, we should not be led into digressions by attractive and familiar subjects which might interfere with the systematic teaching of the science.

The usefulness of instruction in chemistry can be very much increased by the employment of illustrations from things outside the laboratory. The sole preparation for life is received by the great majority of pupils in the secondary schools and the teacher of chemistry should not be unmindful of his responsibility. It is useless to claim that chemistry is a study of real things and not simply a disciplinary subject, unless we can show that it is so. Excursions should be made to factories where chemical processes are employed and pupils may be asked to write up reports of their observations and show their relation to the facts gained by study and laboratory investigation. Interest may also be added to the special subject of study by reference to the life and work of the chemist whose name is associated with it. In this way the pupil will be put in touch with the history and literature of the subject.

These various forms of outside illustration do not involve a loss of time, for they serve to fix the points of real chemical value in memory while they lend added interest to facts that might otherwise seem dry. Another advantage of this plan is that a means is offered of continually relating the subject to geology, physics and biology which will show the student the interrelation of all

science and will also prove a valuable aid if these subjects are to be taken up later.

With regard to the order in which the subject may be taken up, three somewhat distinct ways may be mentioned. We are thus called on to decide which is best suited to any given group of students. One order proceeds by selecting common materials whose physical properties are most familiar. This order would confine the work to solids, excluding work with gases so far as possible. A second order of treatment begins with familiar materials, but is not restricted to materials familiar because of their physical condition. This order would early include the study of air and the properties of oxygen, passing as rapidly as possible to the theory. This method is more systematic and has less of the nature study idea. In the third order the subjects for study are introduced in such a way as to conform to the historical development of the subject, and the theory is distributed at convenient intervals.

Textbooks are published which illustrate each of these methods of treatment and each no doubt has its advantages. The degree of advancement of the pupil should determine largely which method is most suitable. If chemistry is to be taught to first year students, the nature study plan would no doubt give the best results, but if the subject is to be given during the last years of the course the work might with profit be made to follow one of the other plans. In choosing a textbook and deciding on the order of presentation the teacher must have in mind the degree of maturity of the pupils and the end to be accomplished.

The course should be designed in the interests of the pupil, without reference to whether he is going to college afterward or not. The knowledge of formal chemistry gained in a high school can be of little use, but if the subject is so presented that it develops habits of self-reliance, creates ability to reason surely about the causes of physical phenomena and teaches the pupil to devise means to accomplish definite ends, it will prove invaluable.

Chemistry at first was taught in the high school almost entirely by means of a textbook, supplemented more or less by illustrative

experiments. But with a broader conception of the science the textbook method began to give way to the laboratory method till now pupils have ceased to read and listen to statements of facts and theories and have begun to work and think. The laboratory however should not become the only means by which a knowledge of chemistry is gained. While some phases demand experimental treatment others may best be developed by demonstrations. The laboratory should be made the foundation on which all instruction rests, but the work done there should be closely correlated with the subject as presented in some good textbook, otherwise the pupil will lack fulness in knowledge of the subject and will fail to get a definite grasp of the relations of the parts of the science. There will be hardly a chemical change of which the pupil can make a complete study and, in order to gain the necessary information for reaching the conclusions to which his experiment points, it will be necessary to consult books. While the laboratory work is real it is often incomplete. The practical work in the laboratory and the study of the textbook should go hand in hand.

There is nothing magical about a laboratory as a teacher of chemistry any more than about a Latin room for the teaching of Latin. It is the constant presence and supervision of the teacher, coupled with continual questioning, that can keep the work up to the level of an intellectual exercise. Used as the laboratory sometimes is, it is little better than the old illustrative method. It is not a magnified kindergarten where pupils may seek relief from the brain fag induced by their other studies. Its tasks are real and inspiring, intellectual and manual. Its educational value depends on the development of skill in manipulation, of correct habits of observation and recording results and of the real spirit of scientific thought.

To get the greatest amount of profit from laboratory work the principles there investigated must be driven home by careful questioning, numerical problems, written reviews, brief lectures, excursions, essays and collateral reading. The work should be

so conducted that the pupil will not get the idea that the laboratory is simply a place where he weighs and measures.

The quiz is of great value as a supplement to laboratory instruction, as it enables the teacher to determine the individual experience of the pupil, to locate his particular difficulties and to enable him to draw out much that was unheeded at the time, but is called out by questioning. The statements of the textbook are also in this way related to the laboratory work and thus they are prevented from becoming two separate things. The quiz also brings out the generalizations of the science from facts observed in the laboratory and enables the teacher to point the application of these to the solution of chemical questions and to the experiences of everyday life.

Laboratory work should not resemble a personally conducted tour of the subject, covering the greatest amount of ground in the shortest possible time, but should be made intensive rather than extensive. A thorough knowledge of a small portion of the subject gives greater power to master other parts than is gained by passing rapidly from group to group of things which are less closely related. It is the superficial treatment of chemistry in the high schools that prevents the recognition of such work by colleges and requires that the student on entering take up the subject from the beginning.

The aim of a high school course in chemistry is not to impart a definite amount of chemical information, to require the performance of a fixed number of experiments or to make of its students finished chemists. The real object is to develop a love for truth, to strengthen the mental power for logical reasoning and to cultivate the habit of experimental observation. If, at the same time, the work furnishes results which are of real value as an addition to the student's stock of useful knowledge so much the better.

DESIRABLE CHANGES IN THE REGENTS COURSES IN CHEMISTRY AND PHYSICS

BY G. M. TURNER, MASTEN PARK HIGH SCHOOL, BUFFALO

It is with considerable reluctance that I take up the consideration of changes in the present courses in chemistry and physics of the Regents *Syllabus*, because I recall the effort put forth by this association 4 years ago and 5 years ago, to assist the Regents in putting forward acceptable laboratory courses in chemistry and physics. Certainly the work of Professor Hallock and his committee in preparing the present laboratory course in physics, and of Professor Woodhull in presenting the basis for work in chemistry, is not to be passed over lightly. Naturally I hesitate to criticize the work of these men. I can only feel justified in so doing by recalling that time changes the viewpoint of us all and that the aims of a course in physics or chemistry for the secondary schools of New York are, and ought to be, different today from what they were 5 years ago. The present courses have accomplished much in encouraging laboratory work in schools where 5 years ago but little or no laboratory work was done. They have also aided in creating a sentiment in favor of full year courses where before only one half year's work was done. Since the past 5 years have made an advance in our work in chemistry and physics, it is but proper that we so plan that the next 5 years may see a still greater advance in our methods of presentation and better work accomplished.

If I interpret rightly the trend of the more recently published chemistries and physics, intended for secondary school work, there are two things at which all the better books aim, viz, the cultivation of a scientific attitude of mind in the pupil and incidentally the teaching of utilitarian facts. Of course I do not wish to be understood as referring to any attempt to make chemists or physicists out of these boys or girls, but to inculcate into their manner of thinking and manner of work, a spirit that is in keeping with the best scientific training. Along with this training to furnish these young people facts bearing on everyday processes

and phenomena. That this situation is a reality and not a phantom to be reasoned or imagined away, will, I think, be conceded by any one who carefully considers the character of the books used and the nature of the instruction given, by the best teachers in our secondary schools of today.

If this combined scientific-utilitarian viewpoint is conceded, how do our present Regents courses in physics and chemistry fit with the same? Apparently, the courses and examinations come far short of meeting this situation. I grant it is a comfortable thing for the teacher and pupils to feel that so long as the school is on the approved list, the pupils are to get their credit, provided the proper time has been spent in the laboratory. But it is not enough to say that 20 credits of the examination shall be given on account of the equipment of the school and the fact that a pupil has spent so many hours in the handling of this equipment. Such a system does not put the proper responsibility on the pupil for his utilization of this equipment, or test his use of the hours spent in the laboratory.

If you will pardon a personal allusion to the subject, I may say that while the work at Masten Park High School has met the approval of the Regents inspectors, and it has been our endeavor at Masten Park to merit this approval, I can not but appreciate the situation and experience the feeling that the present system brings. I have frequently realized that quite a few of my pupils have a wrong viewpoint of their laboratory work. To some, the work is for the purpose of quickening the eye, the hand and the reasoning powers. To others, the work is looked on as something necessary to be carried out in order to make their final examination less troublesome.

By this I would not wish to be understood as advocating that the examinations be made more difficult, but that the whole viewpoint be so changed that the pupil will be stimulated in his laboratory work to approach the examination from a different standpoint. To do this it is my belief that the examination should not merely test the students' memory of facts, or ask for the description of an experiment illustrating a law, where the pupil

may furnish a hypothetic experiment, either created by his imagination or crammed from a textbook, the real nature of which experiment is entirely unknown to him. An examination should properly test the actual manipulative work of the pupil, his mental processes and his attitude of mind toward the subject, by requiring his description of the necessary precautions to make his experiment a success; how to proceed in order to avoid certain errors of work or errors of judgment; to give satisfactory reasons why the temperature and pressure conditions should be taken into consideration in working with gases; why some experiments necessarily produce greater errors of result than do other experiments or other parts of the same experiments; why utilizing a piece of apparatus in one way, rather than in another way similar to it, will yield better results. Such tests as these tend to stimulate the training of the pupil along right lines and it is proper that our Regents *Syllabus* and examination should encourage this class of work and the examination should be based on the same.

Perhaps I may be accused of laying too much stress on the examination side of the problem and I may be told as our principal periodically tells the pupils of the Masten Park High School: that the Regents examination is only an incident and that the term work is the thing that counts. Grant this to be true, yet the child is rare—the grown child too for that matter—who approaches an examination with a sense of relish and delight. No matter how well prepared a pupil may be, the element of uncertainty about an examination coming from a source outside of the school produces a disturbance in the equilibrium of the child. This disturbance is usually in the inverse ratio to the preparedness of the pupil, and with nervous children frequently varies inversely as the square of the preparedness. It is for this reason that I would advocate that the examinations in chemistry and physics be less of a memory test and more of a deduction test of the work done by the pupil in the laboratory.

But I would be promptly told that there are, and must be, many schools in New York State that are unable to do much, if any,

laboratory work, both from lack of equipment and from the qualifications and excess work of the teacher; and that such an examination would be unfair to these schools. The answer to this brings me to one of the most radical changes I would suggest for the next 5 years.

It has been my belief for some time that it is impossible for the Regents to issue one examination in physics and one examination in chemistry that will properly deal with the work done in the different high schools of the State. When one considers the radical difference between the possibilities for work in the high school of a small town, where the teacher of physics and chemistry must of necessity be handicapped, not only by lack of proper room, insufficient equipment and the necessity of teaching three or four subjects beside physics and chemistry, and the possibilities for work in a high school like this Syracuse building, the difficulty becomes very apparent. Either the stronger or the weaker school is the sufferer. Surely the needs and possibilities of the smaller school should be as carefully considered as the needs of the larger school. With one examination and one syllabus, either too much is asked of the one or not enough of the other.

To relieve this difficulty I would suggest that the Regents outline two courses of work in physics and two courses of work in chemistry. I would also suggest that two examinations in each subject be issued at each examination date. As a consequence, the schools of the State would be divided, so far as physics and chemistry are concerned, into two groups; one group taking one examination and the other group taking the other examination. It should be within the jurisdiction of the Regents inspector to decide whether a given school, by its possibilities for work and its desires, should be placed in the one or the other group.

By this means more work and work of a different class, might be expected from the one group than from the other. Naturally the amount of laboratory work in the one group would not only be greater in quantity, but contain a greater number of quantitative experiments, than would be expected from the other group.

The examinations would in the one case be somewhat like those now given, based largely on the textbook work; in the other case less of mere memory work based on the accumulation of facts and definitions, might be expected, and more questions based on processes employed in laboratory work, be found.

In regard to the practicability of the two course scheme, it is quite possible our friend Cobb, who I know delights in work, may tell you that the extra energy necessary to plan two outlines of work and two examinations, is easily cared for, but that the dividing of the schools of the State into groups where results of a different degree are offered, will interfere with the present system of requiring the different schools to come up to a given standard, in order to be acceptable. To this I would say that while the fact of even gradation of the school work has been one of the established systems of the Regents, it does not follow that it always need continue so to be. The separating of the high schools of a state into grades, requiring not only different amounts of work, but work of a different quality from some schools than that expected of other schools, is being tried and apparently finding favor in other states. It is certainly perfectly logical that more should be expected of the school with five talents than from the school possessing only two or one talent.

Assuming the practicability of the two course system, what should be offered in each system? It would seem advisable that the more extensive and intensive of our courses should be of such a nature, that the ground covered would be suitable for admission to the average college of the country, and embrace work similar in character to that laid down by the College Entrance Examination Board in its last *Definition of Requirements*. As this syllabus is of a recognized merit and standard among the colleges, similarity of work to this course, in our schools that fit for college, would be of great value, not only in preparing our boys and girls for college but in giving those who do not go to college an excellent course in the training we seek to give them.

Such a syllabus as that above mentioned would modify our present syllabus in several respects:

1 In the chemistry course it would introduce a fair amount of quantitative work. The present syllabus has practically no work of this nature.

2 In physics, the course above mentioned would omit some of the experiments that the experience of the past 3 years shows to be too difficult for pupils of the secondary schools.

3 It would shift some of the experiments laid down as laboratory experiments, to the lecture table.

4 It would introduce several experiments not now touched on, particularly with reference to the construction and operation of the dynamo and motor.

5 It would lay more emphasis on certain portions of the text-book work and less emphasis on other portions of the same.

6 It would do away with the use of parts 1 and 2 in both physics and chemistry. It is possible, there was a time when the division of physics and chemistry into parts 1 and 2 was desirable and it was proper that an examination with credit be given in each part. It is my belief, however, that such a time has passed and that all the schools entitled to any credit for work in physics or chemistry, should, in a more or less thorough degree, complete the subject. I can not believe that good work, even in our less favored schools, is fostered by allowing credit for work done on mechanics and heat as distinguished from sound, light and electricity. Neither do I see why two thirds of the work of the year as now arranged for in chemistry should be called part 1 and receive distinct credit from the remaining one third that is as closely connected to the second third as was the first one third. Surely there is no logical distinction or chemical division that puts all the metallic elements and all the nonmetallic elements, except carbon, phosphorus and arsenic, into one group, as part 1, and sets the three above-mentioned elements in a separate group by themselves, as part 2. Such a grouping leaves a false impression with the pupil and renders an examination where one half the questions must be selected from the three elements and their

compounds, and one half the questions selected from the other 22 elements and their compounds, decidedly unbalanced. It would certainly seem that the terms, part 1 and part 2 as at present used, have outlived their usefulness and might safely be dropped.

As a course and an examination for those schools that feel unable to do the work of the more strenuous course, I would suggest a course having the same aim of training the pupil in right methods of thinking and work, as the previously discussed course, but make the work less comprehensive, with fewer required laboratory experiments. These experiments might naturally be based on as simple apparatus as possible, where satisfactory results can be obtained. Such a course would keep the same aims in view as the other course, but require only such work as the possibilities of the smaller school will allow.

It would thus seem that by making the courses in chemistry and physics for the next 5 years, as far as possible, with a view to cultivate the scientific attitude of mind, coupled with the necessary facts to make this training possible, and by fitting the examinations and work to the possibilities of the individual school and the requirements of our colleges, a standard would be set that would be beneficial in its effects.

Tuesday afternoon

GENERAL SESSION

ALCOHOL AND NARCOTICS

SCHOOL INSTRUCTION REGARDING THE EFFECTS OF ALCOHOLIC DRINKS AND TOBACCO

FINAL REPORT OF THE COMMITTEE

PRESENTED BY BURT G. WILDER, CORNELL UNIVERSITY

IRVING P. BISHOP, Chairman, State Normal School, Buffalo

BURT G. WILDER, Cornell University

GAYLORD P. CLARK, Syracuse University

ELI H. LONG, University of Buffalo

JAMES E. PEABODY, Morris High School, New York city

A Report of the Physiologic Subcommittee of the Committee of Fifty

B Alcohol: is it Ever a Food or Always a Poison?

C Effect of Alcohol on the Various Organs and Functions of the Body

D Physiologic Effects of Tobacco

E Teachers and the New York State Law

F The Connecticut law

G Appendix. Modifications of the Preliminary Report of 1901

The New York State Science Teachers Association, at its meeting in December 1898, appointed a committee of five "to ascertain and report what is definitely known regarding the physiological effects of alcohol and narcotics on the human body, and to recommend suitable methods for teaching the same in the schools of this State." After three years of discussion and correspondence, this committee presented to the association a preliminary report, the outline of which was as follows:[1]

1 A comparison of textbooks used in medical colleges and in the public schools of the State of New York

2 Opinions of the committee regarding the effects of alcohol

3 Opinions of teachers regarding present methods of teaching physiology

4 Conclusions of the committee from the preceding investigation

5 Recommendations of the committee

At the 1901 meeting mentioned above it was voted that our committee be asked to continue its work and to make its final report at a subsequent meeting. As the work has progressed the members of this committee have been more and more impressed with the magnitude and difficulty of the task. Soon after the publication of our preliminary report, however, we were given access to the advanced sheets of the most important of all modern books relating to the alcohol question, ***The Physiological Aspects of the Liquor Problem*** (two volumes, octavo, p. xxii, 396 and 379. Houghton, Mifflin & Co. Boston and New York, $4.50).

To this work of the physiologic subcommittee of the Committee of Fifty we are indebted for a considerable portion of the material contained in sections A, B and C.

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[1] *This* report was published in High School **Bulletin 17 of the University** *of the* State of New York and in the **Educational Review, June 1903.**

A REPORT OF THE PHYSIOLOGIC SUBCOMMITTEE OF THE COMMITTEE OF FIFTY

The Committee of Fifty was organized in 1893, "in the hope," as stated in the announcement, "of securing a body of facts which may serve as a basis for intelligent public and private action. It is the purpose of the committee to collect and collate impartially all accessible facts which bear on the problem, and it is their hope to secure for the evidence thus accumulated a measure of confidence on the part of the community which is not granted to partizan statements." In brief it is a committee for the impartial investigation of facts. It is composed of able representative men of various religious, political and social views. Its president is the Hon. Seth Low, and the several subcommittees are made up of men eminent in their several departments.

The Physiological Aspects of the Liquor Problem was published in June 1903. It constitutes the fourth of the preliminary reports on different aspects of the liquor problem prepared and published under the authority of the Committee of Fifty as a basis for the "general discussion that may in the future be undertaken by the committee as a whole." The subcommittee consists of John S. Billings, *chairman and editor of report,* New York Public Library; W. O. Atwater, Wesleyan University; H. P. Bowditch, Harvard Medical School; R. H. Chittenden, Yale University, and W. H. Welch, Johns Hopkins Medical School. Following the report of the subcommittee as a whole to the Committee of Fifty, come nine special reports, viz, The Present Instruction on the Physiological Action of Alcohol (136 pages), by H. P. Bowditch and C. F. Hodge; The Influence of Alcohol and Alcoholic Beverages on Digestion and Secretion (171 pages), by R. H. Chittenden; Data Relating to the Use of Alcoholic Drinks among Brain Workers in the United States (32 pages), by J. S. Billings; Relations of Drink Habits to Insanity (18 pages), by J. S. Billings; The Influence of Alcohol on Growth and Development (20 pages), by C. F. Hodge; The Influence of Acute Alcoholism on the Normal Vital Resistance of Rabbits to Infection (19 pages), by A. C. Abbott; A Critical Review of the Pharmacological Action of Ethyl

Alcohol with a Statement of the Relative Toxicity of the Constituents of Alcoholic Beverages (168 pages), by J. J. Abel; The Nutritive Value of Alcohol (180 pages), by W. O. Atwater; the Pathological Action of Alcohol (26 pages), by W. H. Welch.

The work above described has been carefully studied by your committee. Notwithstanding minor defects and the notable inadequacy of the index, *The Physiological Aspects of the Liquor Problem* attests the learning and skill of the collaborators and the impartiality of the committee. In our judgment it is the most complete, the most scientific, and the most trustworthy consideration of this phase of the liquor problem that has ever been published. It constitutes at once the most extensive and the most powerful of temperance tracts.

Holding this opinion of the work your committee suggest that it be placed in the libraries of all the public schools of the State, and that perfect freedom to consult it be accorded not only to teachers but to all pupils as well.

Physiological Aspects of the Liquor Problem begins, as has been said, with the joint report of the subcommittee to the Committee of Fifty. Their general conclusions are stated on pages xix–xxii. Probably no two men, or bodies of men, would summarize the volumes in just the same way, and your committee think the conclusions might be advantageously modified or amplified in certain respects. In the main, however, they seem to us so moderate, so sound, and so warranted by the known facts that we print them in full:

PHYSIOLOGICAL ASPECTS OF THE LIQUOR PROBLEM

INVESTIGATIONS MADE BY AND UNDER THE DIRECTION OF W. O. ATWATER, JOHN S. BILLINGS, H. P. BOWDITCH, R. H. CHITTENDEN AND W. H. WELCH, SUBCOMMITTEE OF THE COMMITTEE OF FIFTY TO INVESTIGATE THE LIQUOR PROBLEM. OCTAVO, 2 V., P. XXII AND 396, AND 379. HOUGHTON, MIFFLIN & CO. 1903. I, P. XIX-XXII.

The object which the committee had in view was, as indicated above, to ascertain the effects of the occasional or habitual use of a moderate quantity of wine, beer, or spirits upon the health and working powers of man. As to the term "moderate quantity," the committee accepted the use of this phrase among English phy-

sicians as formulated by Anstie, viz, the equivalent of one and one half ($1\frac{1}{2}$) ounces of absolute alcohol per day, or about three (3) ounces of whisky, or half a bottle of claret or Rhine wine, or four (4) glasses of beer; it being understood that this is to be taken only at lunch and dinner, and that the whisky is to be well diluted.

Conclusions

As the result of their investigations and deliberations the committee have arrived at the following conclusions:—

1 The effects of a moderate or occasional use of alcoholic drinks upon man differ greatly in different individuals, and depend on constitutional peculiarities, age, occupation, climate, etc. Most of them, especially the ultimate effects upon health, can not be ascertained with much accuracy by experiments upon animals or upon a few men for short periods of time.

2 The results of the many experiments of this kind which have been made up to the present time appear to us to be fairly stated in the papers by Professors Abel, Atwater, Chittenden, and Welch, printed with this report. The committee agree upon the general and more important conclusions of these papers after careful examination and personal conference.

3 We have no trustworthy data as to the proportions of total abstainers, occasional drinkers, regular moderate drinkers, and positively intemperate persons in the United States. From such information as we have, it seems to us probable that of the adult males in this country, not more than 20% are total abstainers, and not more than 5% are positively intemperate in the sense that they drink in such excess as to cause evident injury to health. Of the remaining 75% the majority, probably at least 50% of the whole, are occasional drinkers, while the remaining 25% might perhaps be classed as regular moderate drinkers.

With the majority of these occasional drinkers, and with many of the regular moderate drinkers, such as those whose drinking is limited to a glass of wine or two, at dinner, no especial effect upon health seems to be observed either by themselves or their physicians, but in some cases the drinking is certainly harmful, while in a few it is thought to be beneficial.

4 Among the leading brain workers of the United States, as indicated by the statistics on page 313, volume 1, of this report, it would appear that about 80% use alcoholic drinks occasionally or regularly in moderation. The opinions of these men as to the effects of alcoholic drinks in general have little or no scientific value, but are of interest as showing that the use of such drinks to stimulate mental effort gives, on the whole, bad results.

We believe that such occasional or moderate use is most likely to be harmful to young persons, and mainly because of the danger of its leading to excess; and that the cases where it is useful, otherwise than in disease, are mostly those of persons over 50 years of age and when alcoholic beverages are taken with the last meal of the day.

5 The special effects of alcoholic drinks are mainly due to the alcohol they contain, and, so far as these effects are harmful, the other substances are of comparatively small importance. Fine old whiskies and brandies are nearly as likely to produce injurious effects as are the cheaper grades of the same liquors, if taken in the same quantities. Some wines appear to delay or check the digestive process by reason of other constituents than alcohol, as is shown by the experiments of Professor Chittenden with regard to the effects of claret. In general the injurious effect of an alcoholic drink is in proportion to the amount of alcohol contained in it, which seems to be the chief reason why wine and beer are less injurious than distilled liquors.

6 The question as to whether a given alcoholic drink is a food or a poison is one which can not be answered by any short comprehensive formula. In moderate quantities, beer, wine, and diluted whisky are, in a certain sense, foods; but they are seldom used for food purposes, but mainly for their peculiar effects on the brain. In large quantities, and, for a few persons of peculiar temperament, even in moderate quantities, they are poisons.

7 Alcoholic drinks in moderate quantities may be useful as restoratives in fatigue after the work is done, but they often produce a depressing and even harmful effect when used just before or during physical or mental labor. They are useless as preventives of infectious or contagious disease; on the contrary, they appear to lessen the power of the organism to resist the effects of the cause of such disease.

8 The report prepared by Dr H. P. Bowditch of Boston, and Prof. C. F. Hodge of Worcester, Mass., on the present instruction on the physiological action of alcohol, is believed to be a correct representation of the facts, and to justify the conclusion that much of the methods and substance of the so called scientific temperance instruction in the public schools is unscientific and undesirable. It is not in accord with the opinions of a large majority of the leading physiologists of Europe as shown by the statement printed on page 18 of volume 1 of this report. This appears to us to be a matter of grave importance.

9 It does not seem to this subcommittee desirable to attempt to give systematic instruction to all children in the primary schools

on the subject of the action of alcohol or of alcoholic drinks. To older children, and especially those in the high schools, it does seem proper that instruction should be given as to the principal facts known about the use and effects of alcoholic drinks, the sociological and especially the ethical relations of the subject, the means which have been tried to prevent the evils resulting from alcoholism—and the results,—the object being to enable them to form an intelligent opinion upon the whole subject, especially to distinguish between mere assertions and scientific evidence.

10 This teaching should not be made a special, isolated matter, but should be a part of some elementary instruction in physiology and hygiene, and all that is really useful and desirable can be given in a brief time, equivalent to a few lessons of an hour each, following the lessons on food. In these lessons might be taught what the ordinary alcoholic drinks are, and of what and how they are made, the difference between simple fermented drinks, like beer and wine, and distilled liquor, such as whisky, the nature of the so called "temperance drinks," and the general effects of alcohol as a stimulant and as a narcotic. It might be taught that while in moderate quantities beer and wine may be, in a certain sense, a food, they are a very imperfect and expensive kind of food, and are seldom used for food purposes; that they are not needed by young and healthy persons, and are dangerous to them in so far as they tend to create a habit; that in certain cases of disease and weakness they are useful in quantities to be prescribed by physicians; that when taken habitually it should be only at meals, and, as a rule, only with the last meal of the day, or soon after it, and that alcoholic drinks of all kinds are worse than useless to prevent fatigue or the effects of cold, although they may at times be useful as restoratives after the work is done.

It should also be taught that alcoholic drinks are almost always a useless expense, that their use in excess is the cause of much disease, suffering, and poverty, and of many crimes; but that such use is sometimes the result, rather than the cause, of disease.

It should not be taught that the drinking of one or two glasses of beer or wine by a grown up person is very dangerous, for it is not true, and many of the children know by their own home experience that it is not true.

[*Signed*] JOHN S. BILLINGS, *chairman*
W. O. ATWATER
H. P. BOWDITCH
R. H. CHITTENDEN
W. H. WELCH

B ALCOHOL: IS IT EVER A FOOD OR ALWAYS A POISON?

Various constituents of liquors. Alcoholic beverages owe their attractiveness in part to ethers and flavoring matters contained in them. They also contain small portions of fusel oil and other lighter alcohols. It has been popularly believed that the deleterious properties of certain distilled liquors were largely due to these latter ingredients. Abel's results prove very clearly that neither the flavoring matters nor the lighter alcohols have much influence in producing intoxication or the other bad effects of liquors. Ordinary ethyl alcohol is the principal intoxicating agent and the other impurities may be neglected altogether as the source of the drink evil. So far as quality is concerned the best whiskies are as capable of producing intoxication as the poorest. The principal adulterations of liquors are water, flavoring extracts and coloring substances not injurious to health. [Physiological Aspects of the Liquor Problem, 2: 4-34]

Alcohol as a possible source of energy. In what part of the body alcohol is oxidized is not known, nor is its action within the body yet fully understood. Stated broadly, our knowledge indicates that in occasional small quantities the cells of the body oxidize it and dispose of it without demonstrable harm to the tissues. Also that the energy liberated is available for the same purposes as that derived from the oxidation of other foods. The composition of alcohol is similar to that of sugar and starch, and the logical inference is that it may serve the same purpose in the body. For a long time it was taught in the school texts that this was not true, but that the greater part of the alcohol ingested was excreted unchanged. It has now been demonstrated beyond doubt that alcohol to the extent of about 2 ounces in 24 hours is oxidized as completely (90 to 96%) as other foods. Since the oxidation of a substance liberates energy, alcohol is regarded by many as a true food substance. On the other hand, it is claimed that alcohol produces other deleterious effects which more than counterbalance the good, and render it valueless as a food. Those who favor this view contend that a true food must always nourish the body without harming it.

Alcohol as a poison. If too much alcohol be taken at once, or if the quantity taken during 24 hours be much larger than 2 or 3 ounces, harmful results may follow. In the minimum quantity indicated it is believed that oxidation of alcohol is as complete as with sugar or starch. If the quantity of alcohol is greater than the body can thus dispose of, the evidence at hand indicates that the unoxidized portion, circulating in the blood, produces poisonous effects on the cells. In this way alcohol acts as a poison. The nerve cells seem specially susceptible to its influence, the alcohol affecting them like a narcotic or anesthetic. In excessive doses it may act as a poison, producing serious nervous and functional disturbances, or even death. The quantity which may produce deleterious results depends largely on the individual, some persons being much more susceptible to its influence than others. There is no standard by which the intoxicating or poisonous dose may be always known.

It has been claimed that since alcohol in large quantities acts as a poison it should always be classed with poisons. Also, that since the structure of one alcohol molecule is like that of any other, the smallest quantity must also be poisonous. On the other hand it is contended that a substance is poisonous or not according to the quantity used; that in small quantities a substance may be harmless or even beneficial but in large doses may produce disease or death. Much of the controversy on this point has arisen from lack of concord as to definition. Abel states the matter as follows:[1]

According to scientific usage any substance is called a poison which, when incorporated into the blood, or even when applied to the mucous membranes and other surfaces, in relatively small amounts, causes disturbance in any function of the body. It is difficult to give a satisfactory definition of a poison.

Without entering on a long definition of the term, we may remark that, without exception, all poisons are capable of being taken without *demonstrable* injury in a certain quantity, which is, for each of them, a special though sometimes very minute fraction of their toxic or fatal dose. There is no substance which is always and everywhere a poison. The term is relative; condi-

[1] Physiological Aspects of the Liquor Problem, 2:5.

tions and circumstances of various kinds must always enter into the conception of the term. No one would maintain, for example, that a cup of delicately flavored tea is in any sense injurious or poisonous to the average healthy adult. And yet caffein, the active principle of this cup of tea, is a poison as surely as is alcohol. When used in a strictly scientific sense, the term applies with equal propriety to a number of other food accessories, as coffee. pepper, ginger and even common salt. In this last instance the toxic dose is large.

While agreeing in the main with Abel, Hewes[1] classes alcohol as a poison because that is one of its most characteristic properties. To the child, however, who gets his ideas from the school text, the word poison suggests a substance which always produces immediate bodily harm.

From what has been said it is seen that alcohol may act in the body in small quantity as a food and in larger quantity as a poison. While its food value is conceded, it is not claimed that it is an economic food suited to general use. As a source of energy, alcohol costs several times as much as an isodynamic quantity of ordinary food.[2] In certain forms of disease, as in pneumonia or

[1]Hewes, H. F. M.D. Value of Alcohol as a Therapeutic Agent in Medicine. Bost. 1902. Damrell & Upham. p.4-5.

[2]Assume 1 pt of beer to weigh 1 lb.

Assume cost of beer (1 pt) to be 5c.

Assume cost of 1 lb of sugar to be 6¼c.

Assume cost of 1 lb of butter to be 30c.

Assume cost of 1 lb of bread to be 7c.

1 lb of bread contains .078 lb available protein and 1200 calories energy.

1 lb of beer contains no available protein and 220 calories energy.

Accordingly 5.45 lbs of beer furnish the same available energy as 1 lb of bread.

The beer would cost 27.5c or about four times as much as the bread.

1 lb of sugar contains no protein and 1755 calories energy.

1 lb of beer contains 220 calories energy. Therefore 8 lbs of beer would furnish the same energy as 1 lb of sugar. The beer would cost 40c or about 6½ times as much as the sugar.

1 lb of butter furnishes .01 lb available protein and 3410 calories energy.

1 lb of beer furnishes no protein and 220 calories. Therefore 15.5 lbs of beer would furnish the same available energy as 1 lb of butter.

The beer would cost 77.5c or about 2.6 times as much as the butter.

The bread contains considerable protein. Disregarding that, the available energy furnished by beer costs 4 times as much as the same amount furnished by bread; 6½ times as much as that from sugar; and 2.6 times as

typhoid fever, where the patient can not take ordinary food, many physicians claim that alcohol may be used to advantage in quantities which under ordinary circumstances would intoxicate, while some, on the other hand, deny for it any great value.[1] Since it does not require digestion, it acts in such cases as an emergency food tiding over a period of stress. To people in health, however, alcohol is unnecessary and its use is constantly attended with danger of forming the alcohol habit. It is proper to say, however, that nearly all of the above statements are disputed on more or less eminent authority.

The committee believes that the question of the food value of alcohol which has been the subject of so much controversy should have no special prominence in public school physiology. A limited number of people use alcoholic liquors as tea and coffee are used, as food adjuncts to stimulate the appetite, to promote good fellowship or to highten the pleasure of the meal. Comparatively few Americans use them in the place of ordinary foods. Unless attention were drawn to the subject through the school texts, most children would never know that alcohol is ever thought of as a food.

C EFFECT OF ALCOHOL ON THE VARIOUS ORGANS AND FUNCTIONS OF THE BODY

Salivary digestion. The work of R. H. Chittenden and his assistants has given us very definite information regarding the effect of alcoholic liquors on digestion and secretion.[2] When introduced into the mouth, alcoholic liquors produce a marked but transitory increase in the flow of saliva, which has greater digesting power than saliva secreted under ordinary conditions. This increase

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much as that from butter. [Physiological Aspects of the Liquor Problem. 2:342]

It must always be understood, however, that the action of alcohol on tissue is complex and that other factors in its action may hinder the realization of the full potential of its food value.

[1] Physiological Aspects of the Liquor Problem. 2:210; Hewes, H. F. M.D. Value of Alcohol as a Therapeutic Agent in Medicine. Bost. 1902. Damrell & Upham. p.21-22; *and* Anstie, F. E. Stimulants and Narcotics. Phila. 1865. p.375-85.

[2] Physiological Aspects of the Liquor Problem, 1:137 et seq.

is thought to be due to local stimulation of the mucous membrane of the mouth. With active saliva not greatly diluted the presence of 5% of absolute alcohol, equal to 10% of proof spirit, may lead to a slight increase of digestive power. Larger quantities of alcohol cause retardation of starch digestion, but even 10% of absolute alcohol causes only a slight retardation. The action of the alcohol, however, seems to be modified somewhat by the presence of other substances held in solution in it. The principal digestive use of saliva is to change insoluble starch into soluble sugars. This digestion can take place only in an alkalin fluid; hence wines and other liquors containing acids retard the digestion of starchy foods in the mouth, as do vinegar, pickles and salads, because they destroy the alkalinity necessary for the action of the ptyalin of the saliva.

Gastric digestion. As to their influence on digestion in the stomach the same investigators find that alcoholic fluids have a variable effect according to the strength of alcohol present. In strong solution they usually increase both the flow of gastric juice and its percentage of acids and solids. Hence the digestive fluid secreted under the stimulus of alcohol has strong power to digest proteids, like meat and eggs. The time required for stomach digestion under these conditions is not greatly changed—if anything, it is slightly increased. Chittenden and his assistants found that alcohol was rapidly absorbed from the stomach, more quickly than water. They conclude, therefore, that the possible delay of digestion caused by alcoholic fluids would be of shorter duration than the effect of its stimulation on secretion, and, consequently, that alcoholic fluids, where the proportion of absolute alcohol is less than 5 to 10% of the stomach contents, do not markedly influence the time of gastric digestion. Above that proportion, digestive action is retarded. Large amounts of sherry wine and of malt liquors produce a retardation of digestion out of proportion to the quantity used. The retardation is probably due to the extracts dissolved in the liquor. The retardation, however, is no greater than that produced by excessive

quantities of tea or coffee. Robert Hutchinson,[1] however, holds that alcoholic liquors in small or moderate quantities shorten the time of digestion, but in intoxicating doses interfere with it through its action on the nervous system.

It is proper to remark here that there is not complete concord among authorities as to the effect of alcohol on gastric digestion. Hewes, using Chittenden's data,[2] concludes that the presence of spirits in the stomach markedly retards digestion. Other competent investigators are about equally divided in opinion whether they increase or retard digestion and absorption. There is much evidence, however, that by their pleasant taste and stimulating effect they, in many cases, promote appétite and thus indirectly aid in the progress of digestion.

Even if alcoholic liquors do slightly retard digestion, which does not appear to be proven, the fact can have little practical importance. Except to brain workers and invalids who may need to get food out of the stomach and into the blood as quickly as possible, a half hour's time, more or less, in the digestion of a meal can not have a marked influence on health. On the contrary slow digestion may be desirable. The laborer chooses for his fare, not bread and milk which are both nourishing and quickly digested, but pork and corn bread because experience has shown that such food not only maintains strength, but defers the sensation of hunger. Very few of us would be deterred from eating rich desserts because the time of digestion would thereby be lengthened by a half hour. We can not see, therefore, how the knowledge that alcohol impedes digestion could be instrumental in keeping young people temperate.

Pancreatic digestion. According to Chittenden, experiments outside the body indicate that alcoholic beverages delay the digestion by the pancreatic juice both of farinaceous foods and of proteids more than in the cases of saliva or of the gastric juice; but as alcohol is rapidly absorbed from the alimentary canal it probably

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[1] Food and Dietetics. Lond. 1900. p.324.

[2] Hewes, H. F. High School Physiology. 1900. American Book Co. p.107; *see also* Value of Alcohol as a Therapeutic Agent, p.15-16.

exerts little direct influence on the secretion of the pancreatic and intestinal juices or on their digestive action. [Physiological Aspects of the Liquor Problem, 1:249, 301] Zuntz and Magnus Levy also conclude that beer does not diminish the utilization of food by the body. [Physiological Aspects of the Liquor Problem, 1:300]

Effects on the stomach tissues. From various sources there is evidence that the excessive and long continued use of strong spirits may produce gastritis (inflammation of the stomach). In Friedenwald's[1] experiments with rabbits, with large doses of alcohol, gastritis was sometimes produced but was often absent. In their experiments on dogs, Chittenden, Mendel and Jackson[2] found that alcohol in strength ranging from 3.75 to 16% produced no evidence of irritation or hyperemia, and all traces of hemorrhage were absent. The doses of alcohol, however, were not continued for long periods. There is, however, no good evidence of the production of gastritis in healthy human beings from the occasional or moderate use of alcoholic drinks.

Effect of alcohol on the liver. Since alcohol must pass through the liver on its way to the general circulation we should naturally expect to find here, if anywhere, the most marked evidence of its action. The particular disease of the liver attributed to alcoholic agency is cirrhosis ("gin-drinkers' liver," "hobnailed liver"). It is a disease of middle life and may arise from other causes than alcoholism, as for example, the products of indigestion or hepatic derangement. But it is usually the result of protracted indulgence in strong spirits. Welch says, "The immoderate use of alcohol is the cause of probably over 90% of the cases of hepatic cirrhosis, and some think it is the sole cause." [Physiological Aspects of the Liquor Problem, 2:367]

Relatively speaking, however, cirrhosis is not a frequent disease. Osler[3] cites 71 cases as occurring out of 1000 autopsies held in the Johns Hopkins Hospital. Formad[3] found six cases out of 250

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[1] Physiological Aspects of the Liquor Problem, 2:354-56.

[2] American Journal of Physiology, 1:164-207.

[3] Practice of Medicine. N. Y. 1899. Appleton.

post-mortem examinations on confirmed drunkards who had died suddenly from the effects of alcohol. The mortality from this source, therefore, can not be very great. And while the experience of physicians should have due weight, it is worth noting that the various efforts to produce cirrhosis artificially in animals have yielded very meager results. Friedenwald experimented for 4 years on 120 rabbits, using alcohol daily in quantities sufficient to stupefy the animal for a time varying from three to five hours. Genuine cirrhosis was not produced.[1] Similar results have been attained by other experimenters. Fatty metamorphosis of liver cells by the use of alcohol has been artifically produced, but the condition usually disappears with abstinence. These facts lend support to the opinion held by many that alcohol acts only indirectly in producing cirrhosis, or that other special predisposing or associated conditions must be present in addition to the action of alcohol.

Effect on respiration. On this subject much remains to be done. The following points appear to be determined with reasonable certainty by Abel.[2]

1 Alcohol is a respiratory stimulant of moderate power for human beings. During a period of an hour or more after its administration it causes an increase in the volume of the air passing through the lungs and in the absorption of oxygen (3.5%).

2 Highly flavored wines, brandy and other alcoholic beverages which contain larger amounts of stimulating esters[3] have a more pronounced action than ethyl alcohol.

3 The stimulating action of alcohol and of alcoholic beverages is greater in the case of fatigued persons than in those who are in nowise exhausted.

4 Increased heat dissipation always accompanies the above-named effects.

The explanation of this is the supposition that alcohol induces loss of heat from the body through the dilation of the superficial blood vessels, and at the same time causes a compensatory increase

[1] Physiological Aspects of the Liquor Problem, 2:357.

[2] —— 2:116.

[3] "Any compound ether in which both an alcohol radical and an acid radical are present."—*Gould*

in the oxygen intake in order that the loss may be made good by an increased combustion.

Effect on the heart and circulation. As the result of experiments Abel finds that, when introduced into the circulation in moderate doses, and well diluted, with the avoidance of local irritation, alcohol is not a circulatory "stimulant." Under the same conditions it has no direct action on the heart itself either in stimulating or depressing it. It has also, except in unusual circumstances, no general widespread action on the nerves which control the rate and force of the heart beat. It does not act on the muscular wall of the blood vessels (vasomotors), nor on the peripheral terminations of the vasomotor nerves. It acts locally, however, as a temporary irritant on the mucous membrane, and possibly reflexly on the cardiac and vasomotor nerve centers, thus indirectly varying the action of the heart and the caliber of the small arteries (arterioles). This conclusion, however, is not meant to apply when alcohol is used continuously or in large doses. He regards alcohol as always depressant and classes it with anesthetics and narcotics.[1]

In Friedenwald's experiments,[2] fatty degeneration of the muscle of the heart was found in most of the rabbits which died from chronic alcoholic intoxication, but was absent from those which were killed after cessation of the use of alcohol. Other lesions and abnormal conditions were not sufficiently well marked to be attributed to alcoholic agency. It is generally believed however, by physicians, that fatty degeneration of the heart muscle is sometimes the result of excessive but not of moderate use of alcohol.

Effect on the kidneys. In Friedenwald's experiments[3] the evidences of destructive changes in the kidneys due to alcohol were more evident than with other organs, but were not conclusive. In man large and congested kidneys are found with great frequency in those who drink beer to excess. This is believed to

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[1] Physiological Aspects of the Liquor Problem, 2:91-92.
[2] —— 2:358.
[3] —— 2:357-58.

be due, not to the alcohol, but to the extra work of eliminating an excessive quantity of fluid from the blood. Though the experimental evidence regarding the effects of alcohol is not conclusive that from experience leads to the belief that alcoholic excess is injurious to the kidneys.

Effect on the bones. We know of no evidence to show that the use of alcohol directly affects the bones.

Effect on muscular action. Since alcohol is almost entirely oxidized in the body, it is probable, but not absolutely proven, that some of the liberated energy becomes available for muscular work.[1] The recent experiments of Lee and Salant[2] may not, as the authors expressly state, be wholly applicable to the human body, but their suggestiveness is so great as to warrant the reproduction of the "Summary" here.

1 In small quantity (2.37 parts pure alcohol to 1000 parts of body weight) ethyl alcohol does not appear to exert any action on frog's muscle.

2 In medium quantity (40 parts pure alcohol to 1000 parts of body weight) it exerts a favorable action, which is characterized by a quickening of the contraction; a quickening of the relaxation; the power of making a larger number of contractions and of performing a larger amount of work in a given time; an increase in the working time, or, in other words, a delay of fatigue; and the power of making a larger number of contractions and of doing a larger amount of work before exhaustion sets in. This action is exerted directly on the muscle protoplasm itself, not on the intramuscular nerve tissue.

3 In large quantity ethyl alcohol exerts on frog's muscle an unfavorable action, which is, in general, the reverse of that caused by medium quantities of the drug, and is characterized by a decrease in the extent of the contractions; a decrease in the working time, or in other words, a hastening of fatigue; and the power of making a smaller number of contractions, and of doing a smaller amount of work before exhaustion sets in.

Atwater states[3] that "the diet provided for English students in training for boat races commonly includes small quantities of beer or wine," and that Sandow, the "strong man" took beer

[1] Physiological Aspects of the Liquor Problem, 2:269.
[2] American Journal of Physiology. Oct. 1, 1902. 8:61-74.
[3] Physiological Aspects of the Liquor Problem, 2:301.

daily. On the other hand, alcohol affects the central nervous system, weakening the power of control of the muscles and so counteracting, wholly or partly, any advantage which might come from the energy of oxidation. In moderate quantities it may render possible a brief spurt of work which is soon followed by a depression of energy below the normal. Atwater concludes that "the use of any considerable quantity of alcoholic beverages as part of the diet for muscular labor is generally of doubtful value and often positively injurious."[1] Abel declares[2] that "both science and the experience of life have exploded the pernicious theory that alcohol gives any persistent increase of muscular power."

The above expressions are in harmony with the experience of athletes who commonly abstain from alcoholic beverages when training for, or competing in, athletic contests. If used at all, it is to be recommended as an agent to lessen the sense of fatigue at the close of the day's work.

Production of heat. Atwater,[3] in his calorimeter experiments with men, found that only a small part of the heat produced by the oxidation of alcohol was lost by radiation from the surface of the body. With intoxicating doses the loss may be considerable and the temperature of the body may fall several degrees; but with small doses the reduction of body temperature is slight—often too small to be measured by the ordinary clinic thermometer. In Atwater's experiments where 2½ ounces of alcohol were used daily in six doses, the extra heat radiation was only about one tenth of 1% of the whole. He concludes that the alcohol certainly does not waste more heat than it furnishes.

Nervous system and mental functions. In regard to the effect of alcohol on the nervous system there are two theories held today by physiologists and pharmacologists. The first, that of Binz and his followers, is that alcohol, when incorporated in the blood, first stimulates, then depresses the nerve centers. According to Schmiedeberg and Bunge, and this is the view most gener-

[1] Physiological Aspects of the Liquor Problem, 2:279.
[2] —— 2:165.
[3] —— 2:294-97.

ally held among pharmacologists today, it depresses the centers from the start. According to this latter school the apparent excitation which occurs as a preliminary stage in the action of the drug is in reality an increased action of certain subordinate centers resulting from removal of control of the higher centers. This loss of control comes from the depressing or paralyzing influence of the alcohol on these higher centers which normally exert a certain inhibitory control over the lower.[1] In either case the final effect of alcohol is that of a sedative or a depressant. The experiments of Kraepelin[2] and others, while not absolutely conclusive, indicate that moderate quantities of alcohol (15 to 40 grams) shorten the time of simple processes like moving the finger or adding columns of simple figures. Larger quantities than 30 to 40 grams lengthen the time of all types of mental processes. In general the use of alcohol does not enable the individual to perform a greater amount of mental work. Perhaps its most marked effect on the individual is the weakening of his judgment, particularly in regard to subjective conditions. He is unable to judge correctly regarding his own thoughts or his own words. He imagines himself wise or witty when he is the reverse.

Abel, after an elaborate investigation, also decides[3] that, "alcohol is not found by psychologists to increase the quantity or vigor of mental operations; in fact, it clearly tends to lessen the power of clear and consecutive reasoning." He concludes[4] "We have seen that alcohol, from the very first, has a depressant action for the higher mental functions. Hence it is, that in all those vocations of life where keen senses, sharp attention, the ready and immediate action of a clear judgment, or great concentration of the mind are called for, alcohol in any form or amount is injurious when taken *during the performance of the*

[1] Hewes, H. F. Value of Alcohol as a Therapeutic Agent in Medicine. Bost. 1902. Damrell & Upham. p.10-11.

[2] Physiological Aspects of the Liquor Problem, 2:122-25.

[3] —— 2:141.

[4] —— 2:165.

duty in hand. He who has mental labor of an exacting kind to perform, and he upon whom great responsibilities devolve, is forced, if he would be at his best, to use alcohol as a restorative agent only at the proper season; he must behave to it as he does to many other pleasures and luxuries in his environment." Abel thinks, however, that there is a permissible quantity of alcohol which may be taken as a restorative agent. This he represents by a quantity not to exceed the equivalent of half a pint of table wine in 24 hours.[1]

He says further, "It is universally admitted by medical men that alcohol in any form is deleterious to the growing organism."[2]

Stages of intoxication. The effect of alcohol appears to be, as it were, to shave off the nervous system, layer by layer, attacking first the highest developed faculties and leaving the lowest to the last, so that we find that a man's judgment may be lessened, though at the same time some lower faculties, such as the imagination and emotions, may appear to be more active than before, just as I told you that in the case of other parts of the nervous system when you remove inhibition you apparently increase the activity of a center, and that the highest centers have an inhibitory action upon the lower ones.

Thus you find that after a man has taken alcohol his judgment may be diminished, but he may become more loquacious and more jolly than before. Then after a while his faculties become dull; he gets stupid and drowsy. This is the narcotic and anodyne action of alcohol. As a hypnotic it causes sleep; as an anodyne it removes pain; as a narcotic it also disturbs the balance of the faculties, so that the man is no longer able to judge things as he did before, but at the same time the man may still be able to walk.

Later on it affects the motor centers, probably the cerebellum, so that the man is no longer able to walk, and reels whenever he makes the attempt. At this time, however, he may still be able to ride (on horseback), and a man who is so drunk that he can not walk and can not speak may ride perfectly well. The reason of this is that at the time his cerebellum and cerebrum have lost their functional activity his spinal cord is still active, so that the mere reflex stimulus from the pressure of the saddle on the inside of his thighs causes contraction of the adductor muscles, and holds the man in his place on the horse.

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[1] Physiological Aspects of the Liquor Problem, 2:166.

[2] — — 2:129.

Later on the further anesthetic action of the alcohol abolishes sensation, and its paralyzing action destroys the power of the spinal cord, so that the man is no longer able even to ride; but still the respiratory center in the medulla will go on acting, and it is not until enormous doses of alcohol have been given that respiration becomes paralyzed.

Alcohol . . . makes all the nervous processes slower, but at the same time it has the curious effect of producing a kind of mental anesthesia . . . so that these processes seem to the person himself to be all quicker than usual, instead of being, as they really are, much slower. Thus a man, while doing things much more slowly than before, is under the impression that he is doing things very much more quickly. What applies to these very simple processes applies also to the higher processes of the mind; and a celebrated author once told me that if he wrote under the influence of a small quantity of alcohol, he seemed to himself to write very fluently and to write very well, but when he came to examine what he had written next day, after the effect of the alcohol had passed off, he found that it would not stand criticism.[1]

Insanity. The sources of information regarding alcohol and its relation to insanity are taken from the records of hospitals and insane asylums. The data given at the time of commitment of a patient are usually furnished by his friends, and it is quite possible that other causes than alcoholism may be often overlooked. Hence, we are not quite sure that statistical information of this kind is reliable. For some reason the proportion of insanity due to alcoholism seems to vary more widely than the conditions warrant. Of the 1329 cases from insane hospitals reported by the Committee of Fifty,[2] 24.08% were considered due to the influence of liquor. The corresponding figure in statistics collected from Massachusetts is 20.86%. Dr Clouston[3] of the Royal Asylum, Morningside, Edinburgh, places intemperance as the cause of insanity in about 25% of admissions there. Dr William C. Krauss of Buffalo N. Y. has made a careful study of the reports of the New York Lunacy Commission and finds that from 1888 to 1902 the proportion of cases of insanity recorded

[1] Brunton, T. Lauder. Lectures on the Action of Medicine. Lond. 1897. p.190, 191, 194.

[2] Physiological Aspects of the Liquor Problem, 1:341.

[3] Letter from Dr James M. Rutherford, Royal Asylum, to Mr Lawrence Irwell, Buffalo, Ap. 30, 1903.

as due to alcohol in all the New York State hospitals was a trifle less than 9%. From 10 years' experience (from 1891 to 1901) in the insane asylum of Castel d'Audorte in one of the wine-producing districts of France, G. La Laune[1] reports that 5.03% of patients admitted for treatment of various mental affections owe their malady to acute, subacute or chronic alcoholism. This was also practically the proportion for the preceding 20 years.

While, for unexplained reasons the proportion of cases thought to be due to intemperance is variously estimated, the conclusion is irresistible that the use of alcohol is a prolific cause of insanity. And in this fact is to be found a strong argument for abstinence from intoxicating drinks.

Longevity. Regarding the influence of alcoholic beverages on the duration of life the most trustworthy evidence is derived from the records of life insurance companies, benevolent societies, and similar organizations which either have a temperance section or insist on total abstinence as a condition of membership. The evidence is vitiated somewhat by the fact that total abstinence is taken for granted on the statement of the person insured, and there is no way of knowing whether he actually uses intoxicants or not. Brunton[2] gives the following figures selected from the reports of two organizations whose location and other conditions appear to be comparable. The period includes the years 1870-77.

	Average sickness	Death rate
Bradford District Rechabites (Abstainers)	4 days 2 hrs	1 in 141
Bradford District Odd Fellows (Non-abstainers)	13 " 10 "	1 in 44

The Sceptre Association of London has separate sections for moderate drinkers and abstainers. The circular of the company gives the ratio between expected and actual deaths for the 18 years 1884-1901 as follows:

Death rate of moderate drinkers	79.38
Death rate of abstainers	55.12

[1] Medical News, June 20, 1903, p.1173.

[2] Book of Health, 1883.

The United Kingdom Temperance and General Provident Institution, London, has both a "general" section and a "temperance" section. The mortality experience under ordinary whole life policies from 1866 to 1902, 37 years, shows that the ratio of actual to expected claims in the general section was, in round numbers 91%, and in the temperance section 72%, an apparent advantage of about 19% in favor of the abstainers.

The comparative longevity of abstainers and moderate drinkers has been investigated by the Mutual Life Insurance Co. of New York, the investigation being based on its own mortality experience from 1875 to 1889.[1] As the intention was to test the company's own methods regarding a certain group of policies, and for business purposes only, the results may be safely regarded as free from sentimental bias. For the whole period the abstainers had a death rate of 78% while the nonabstainers reached 96% of the maximum expected loss. It was found, however, that the death loss among the nonabstainers was greatest in the earlier years following the issuance of the policy. After the fourth year, the actual loss among the abstainers was 80%, and among the nonabstainers 90% of the maximum expected loss. Taking persons born in the United States by themselves, the percentage was 84% for abstainers and 92% for nonabstainers, a difference of 8% in favor of the former. In conclusion the author says [p.10]:

There is no reason to distrust the general result of this investigation. It coincides with all previous reasonable belief and expectation. It does not show that those who drink only occasionally and not to intoxication, or those who drink habitually but lightly, are in any way injured. It does not show that all of those who drink heavily must therefore necessarily die prematurely. It does show, however, that there is enough injury done to a sufficient number of individuals to make the death loss distinctly higher on the average. Again, it is admitted that death losses in excess among drinkers are not necessarily always due to drink. The coincidence between excessive drinking and lowered vitality may be partly due to bad risks taking to drink, as well as to good risks becoming bad because of drink. On the

[1] McClintock, Emory. On the Rate of Death Loss among Abstainers and Others. Actuarial Society of America. Transactions. Ap. 1895.

whole, however, the teetotal habit, not only before but also after middle age, must be counted as a favorable indication in judging of proposals for insurance from persons not known to be careful and moderate in the use of beverages.

Conclusions

It is plain, therefore, that on many points there is still much difference of opinion among those best qualified to know. Whether alcohol may be a food or is always a poison; whether it lengthens or shortens the time of digestion; how it affects certain organs of the body; whether its use in any quantity is ever permissible—these are some of the questions still open for discussion. The human organism is exceedingly complex and variable, and no one can predict from his own experience what that of another individual may be. For this reason such questions must remain long unsettled. Your committee wishes to say here most emphatically that till they are settled, they should not be made prominent parts of common school education. It is unreasonable to expect a child or youth to decide a question on which the most eminent physiologists differ. It is also unscientific and untruthful to teach either view exclusively as the true one so long as it is a matter of controversy. On certain practical points of supreme importance the committee has seen no reason for modifying materially the views set forth in its report of 2 years ago,[1] and they are here reproduced.

1 All writers agree that an excess of alcohol impairs certain functions of the cerebrum, for example, attention, memory and self control, and that many cases of insanity are due to such excess.

2 What constitutes excess will differ with individuals, with occupations and with other conditions. On the present occasion your committe does not undertake to prescribe the limit of safety for the average adult.

3 The committee does not consider that the stimulative action of alcohol on the system as a whole has been demonstrated, nor is it aware that any authority claims that in health or under

[1] University of the State of New York. High School Dep't Bul. 17. Oct. 1902. p.750-51.

ordinary circumstances, alcohol is an *economical* food, whether for the production of heat or for the protection of fat or proteid.

4 As a matter of fact, the average man in health and under ordinary circumstances disregards these possible rôles of alcohol and takes it because of its flavor or because he finds it conducive to his personal comfort or to good fellowship.

5 Your committee believes that *spirits* should never be used as beverages unless largely diluted, and that alcohol in any form should be taken only at meals and after the work of the day is done.

6 Youths, say under 21, should abstain altogether from alcohol, excepting under specific medical advice.[1]

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[1] The importance of this matter and the natural indisposition of youths to refrain from what is permitted their elders lead the committee to state the grounds of their recommendation categorically as follows:

1 Most parents prefer that their sons should abstain till of age.

2 Several college presidents have advised their students to abstain.

3 Among those who hold very liberal views as to the use of wine by adults, an experienced physician and an expert investigator of the whole subject wrote, respectively, as follows: "I exhort all young people in health not to adopt the practice of drinking wine." *Dr James Jackson* "For youths, say under 25, the proper rule is either no alcohol or very little indeed." *F. E. Antsie*

4 Analogous restrictions based on age are commonly recognized. The infant takes no solid food; the child retires early; the boy is spared severe labor; the responsibilities of marriage, of society and of political life are postponed till a certain development of body and mind has been attained. Is it not then prudent for the youth to defer the use of so potent an agent as alcohol at least till his majority is reached?

5 Seldom, if ever, is there at the outset a real liking for the taste of alcoholic beverages; on the contrary, their use is commonly begun in thoughtless imitation of older persons or of foreigners; an unworthy motive for doing anything of doubtful utility.

6 Comparatively few students live at home or take their meals at private clubs. At school and college boarding tables alcoholic beverages are seldom served; consequently they are likely to be used, if at all, at saloons, where the other conditions are more or less undesirable, and with little or no accompanying food. It is universally admitted that both the local and the general effects of alcohol are most pronounced when taken on an empty stomach.

7 To gain or hold places on athletic teams abstinence is generally required. Even German corps students are beginning to recognize the incompatibility of excessive beer drinking with proficiency in fencing.

8 The foundations of inebriety are commonly laid early. C. L. Dana found that of 210 inebriates nearly all began to drink before 30, and about

Even if we admit, as we should, everything favorable that can be truthfully said about alcohol, that in many cases it adds to the pleasure of life; that it may aid the sick; and that millions of adults use it in some quantity for many years without demonstrable harm; we still have ample reasons why the young should abstain from it. We say the young, because it is the young with whom as teachers we have to deal. It is agreed that alcohol in any form or quantity is not necessary or useful to the growing boy or girl; that with many, though not all, persons the use even of small quantities develops an appetite for liquor which leads to excessive drinking, physical and moral degradation, crime and untold misery. Till he has tried it no one can be sure whether he can control his appetite or not. When he has ascertained the fact it is often too late. The child should be taught to avoid alcohol because it is dangerous to him. The only certain safety for the young lies in total abstinence.

D PHYSIOLOGIC EFFECTS OF TOBACCO

While the literature of tobacco is voluminous, it contains very little of scientific value. Experimental research on tobacco, comparable to that of Abel and Atwater on alcohol, has not been carried on, to our knowledge, either in America or Europe. The facts which we have thought worthy of consideration have been derived principally from (1) standard works on pharmacology; (2) experience of physicians and users of tobacco; (3) results of research, as given in a limited number of papers.

Tobacco contains an alkaloid, nicotin, on which its physiologic effects mainly depend. When smoked, other products more or less poisonous are formed, among which are carbon monoxid, carbon dioxid and pyridin. It has been claimed that the characteristic

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two thirds before 20. *Medical Record*, July 27, 1901; *Quarterly Journal of Inebriety*, Oct. 1901

9 Youth is the age of peril; temptations abound without; appetites and passions are foes within; of all periods of life, in this should a man be ever "on guard," and protected by the community.

10 Habits are most readily and firmly established in youth. Of all the most valuable is the habit of self-control. "The world belongs to those who can control themselves"; but the man who uses alcohol in excess never can do that.

effects of tobacco smoking are due to these by-products and not to the nicotin itself; but this view does not receive the sanction of some of the best authorities.[1] When absorbed into the body nicotin acts, at first, as a brief stimulant of the nervous, circulatory and respiratory systems. This stimulation is followed by a marked depressant action. In concentrated form it is a powerful poison, 60 mg. (.924 grain) being a fatal dose for a man. If inhaled as smoke, not more than 1% of the nicotin in the tobacco is utilized.

At first the use of tobacco generally induces dizziness, nausea, vomiting and more or less prostration. After a few trials, however, the body becomes accustomed to its use, and tolerates it or even demands it. In fact, with many persons, the habitual use of tobacco creates a craving for it which the user finds very difficult to resist. Toleration once established, smoking in moderation produces no unfavorable symptoms on adults, but on the contrary agreeable sensations. "There appears to be a certain repose, which, whilst it neither directly aids nor hinders the psychic processes, leaves the mind free, and in general raises the user's enjoyment of other pleasures. The experience of recent campaigns appears to show that the use of tobacco enables soldiers already accustomed to it to endure greater hardships."[2] On the alimentary tract moderate smoking is thought by many to be beneficial. It produces an increased flow of peptic fluids and increases the powers of digestion.[3] In many cases also it seems to have the effect of keeping the bowels regular.[4]

The study of the action of nicotin on the circulation is not as easy as the study of its action on other portions of the organism. This is because the drug has totally opposite effects if given in large or small doses. Thus, large doses of nicotin paralyze the vagus nerve, smaller doses stimulate it, and still smaller doses seems to have but little, if any, effect on it.[5]

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[1] Sollman, T. Text-book of Pharmacology. Phila. 1901. p.285.

[2] (—— Phila. 1901. W. P. Saunders. p.287.

[3] Seaver, Jay W. Arena. Feb. 1897.

[4] Sollman, T. Text-book of Pharmacology. Phila. 1901. p.288.

[5] Hare, H. A. Use of Tobacco. Phila. 1885. p.31. (Prize essay of Rhode Island Medical Society)

Smoking when carried to excess may produce the "tobacco heart," characterized by irregularity of action with occasional intermission of beats. This condition usually ceases when smoking is discontinued. It is also probable that defective vision may arise from the same cause.[1] Insomnia, general feebleness and lack of coordination of muscles are also attributed to inordinate use of tobacco.

The possible beneficial results that follow the use of tobacco are summed up by Dr Norman Kerr[2] as follows:

Concentration of thought, mental satisfaction, protection against infection, and domestic happiness. There are persons so constituted that the intellectual powers require to be arrested and concentrated before any definite intellectual effort can be entered on. To such persons tobacco smoking has proved invaluable, the advantages far outweighing the disadvantages. No other substance, narcotic or anesthetic, is yet known which would serve the purpose and do so little damage. Were tobacco not known the idiosyncrasies of such individuals would interfere with the achievement and excellence of their work. All with whom tobacco does not disagree realize fully the pleasure and mental satisfaction afforded by smoking. No language can accurately describe the comfort enjoyed from a pipe when one is exposed to severe weather in the trenches or the power it has to stay the stomach-crave for food when no food is to be had; and the action of tobacco under such circumstances can not be considered harmful.

Though the writer (Norman Kerr, London) has not used tobacco in any form for many years and though he is strenuously opposed to its ordinary use, he would not think of going through a yellow fever ward, unless after a full meal, without a lighted pipe or cigar, or cigarette in his mouth.

Then there are many persons, cultured and uncultured, but especially the former, who after an exhausting day's work with head or hands are so worn out and irritable that everything appears wrong from the cooking of food to the playfulness of

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[1] A chronic retrobulbar neuritis may arise from a variety of causes, chief of which is the abuse of tobacco. The victim usually comes early to the physician complaining of some loss of sight with possibly a slight cloudiness obscuring vision. In such cases the ophthalmoscope reveals no signs of a special pathological state, and normal vision soon returns on the discontinuance of the use of tobacco. *Richard Ellis M.D.*, Med. Record, Sep. 25, 1897

[2] Twentieth Century Practice. N. Y. 1895. p.110–11.

children, but who when they have had a smoke are pleased with themselves and all the world beside.

Notwithstanding all that has just been urged in exculpation of tobacco as an inebriating factor, the broad fact remains that it is a potent poison, the general tendency of which is to debilitate the system, stunt growth, and deprave function, that it can not be indulged in except at a certain risk, especially by the young, and that general abstinence from it would greatly promote the health and vigor of the population at large.

Data based on experiments either on man or the lower animals are almost entirely wanting and such as are available are of little scientific importance. The few investigations of which your committee has record have been along the line of growth and development. Jay W. Seaver M.D., physical director at Yale University, has published[1] the results of measurements of students in the Yale gymnasium for 9 years. He finds that smokers are inferior to nonsmokers in size and in every other respect physically except weight. In hight the nonsmokers averaged 7 millimeters greater, and in lung capacity 80 cubic centimeters more than the smokers. The latter, however, exceeded the former in weight by 1.4 kilos. Dr Seaver says:

For purposes of comparison the men comprising a class in Yale have been divided into three groups. The first is made up of those who do not use tobacco in any form; the second consists of those who have used it regularly for at least a year of the college course; the third group includes the irregular users. A compilation of the anthropometric data on this basis shows that during the period of undergraduate life, which is essentially 3½ years, the first group grows in weight 10.4% more than the second, and 6.6% more than the third. In hight the first group grows 24% more than the second and 11% more than the third; in girth of chest the first group grows 26.7% more than the second, and 22% more than the third; in capacity of lungs the first group gains 77% more than the second, and 49.5% more than the third.

These results are essentially the same as those obtained by Dr E. Hitchcock of Amherst College, who observed a similar group of young men in a manner entirely independent. He says: "In separating the smokers from the nonsmokers, it appears that

[1] Medical Examiner and Practitioner, June 1902, p.375–77; *and also* Arena, Feb. 1897.

in the item of weight, the nonsmokers have increased 24% more than the smokers; in growth in hight they have surpassed them 37%, and in chest girth 42%. And in lung capacity there is a difference of 8.36 cubic inches (this is about 75%) in favor of the nonsmokers, which is 3% of the total average lung capacity of the class."

I do not know how we can compare the work of the users of tobacco with that of the nonusers in mental lines as we can in physical lines. I can tell you absolutely whether a man has gained a pound in weight during the year, but I can not tell you by any such definite means the mental progress that has gone on in that time. We must always be exceedingly careful in handling statistics of the mental process. Out of our highest scholarship men only a very small percentage (about 5) use tobacco, while of the men who do not get appointments over 60% are tobacco users. But this does not mean that mental decrepitude follows the use of tobacco, for we may read the results in another way, viz. the kind of mind that permits its possessor to become addicted to a habit that is primarily offensive and deteriorating is the kind of mind that will be graded low on general intellectual tests.

Dr W. P. Lombard of the University of Michigan conducted a series of experiments which seem to prove that tobacco smoking lowers the voluntary working power of the human muscle.[1] His work was done with the ergograph. The result of 33 voluntary muscle contractions gave before smoking 44.8 kgm, after smoking 24.2 kgm. This decrease in muscular power was not accompanied by any compensating duration of working ability.

Whatever difference of opinion there may be regarding the effect of tobacco on adults—and much difference of opinion exists—there is almost complete agreement among those best qualified to know that the use of tobacco is in a high degree harmful to children and youths. Physicians, teachers and others who have much to do with boys very generally remark that those who begin to smoke at an early age very seldom amount to much. Andrew D. White, former president of Cornell University, happily sums up the matter as follows:

I never knew a student to smoke cigarettes who did not disappoint expectations, or to use our expressive vernacular, "kinder peter out." I have watched this class of men for 30 years, and

[1] Journal of Physiology. 1892. 13:1–58.

can not recall an exception to this rule. Cigarette smoking serves not only to weaken a young man's body, but to undermine his will and to weaken his ambition. In colleges having a large percentage of these futile personages they too often give the student tone; they set the fashion; the fashion of overexpenditure, of carelessness as to the real aim and glory of college life. *Cornell Sun*, Nov. 11, 1891

We believe, therefore, that the probable effects of tobacco on growth, physical development and character as indicated above may profitably form a part of school instruction in hygiene, and that the influence of both teachers and parents should be exerted in every practicable way to prevent the use of tobacco by the young. The laws against selling tobacco to boys should be heartily supported and the formation of anticigarette leagues encouraged. The known facts regarding the effects of tobacco on adults, except when it is used to excess, are in our opinion insufficient at present to form a basis for any scientific dictum.[1]

E TEACHERS AND THE NEW YORK STATE LAW

In the public schools of the State of New York there are more than 33,000 teachers. For its size there probably exists no more intelligent, moral, or temperate body. Many of these teachers are active members of temperance organizations. They sustain a closer relation to the child than any one excepting its parents. Too often, indeed, the teacher's is the only good influence under which the child is ever brought. The teacher has the pupil in hand when the foundations of character are being laid, and is keenly alive to his responsibilities. He is predisposed to favor anything tending to the better physical, mental or moral welfare of his charge.

Yet we have reason to believe that of this large body of earnest, intelligent and temperate educators, the majority are not in sympathy with the present scheme of "temperance instruction" or with the state law controlling it. Furthermore, we believe the fault is not with the teachers.

[1] The ethical aspect of smoking is important but the committee determined not to include it in the present report.

Briefly stated, the teachers' side of the case is this: the textbook in the child's hands contains matter which the teacher regards as ill-arranged, partizan, exaggerated, or inaccurate. He must therefore either do violence to his own convictions by teaching what he does not believe, or impair the pupil's confidence by showing that the book contains unwarranted statements and views. It is as if the law enjoined the use of a catholic textbook in a protestant school, or a protestant textbook in a catholic school.

Again, it is the teacher's business to understand the mind of the child and to adapt his instruction to it in such a way that knowledge may be assimilated. To thus adapt it he must have freedom of action. This the law prevents by prescribing not only the amount of instruction but the connection and manner in which it shall be imparted. No such restriction is placed on any other professional man; no other professional man would submit to it. A law which should specify for the physician the kind of medicine and the number of doses he should give, or the number of professional visits he should make, would encounter prompt and merited opposition. What we actually do is to put the case in his hands and trust him to produce the best results of which his knowledge and skill are capable. So, also, when we employ a lawyer we state the conditions and leave the management of the case to his superior judgment. The teachers of this State properly ask that to them be accorded the courtesy and consideration shown the members of other professions.

So far from this being the case, the teachers at large have been ignored or overruled in the framing of temperance legislation. Science and education have been subordinated to a propaganda, and the naturally interesting study of human physiology in the public schools has been converted into the disproportioned and unattractive vehicle of a special reform.

As the result of the antagonism thus aroused there exists the curious and regrettable anomaly of two bodies of earnest people, each desirous of guarding the young against intemperance, at

variance with each other and thus delaying the object for which both are striving. This condition of things should not be allowed to continue. The organizations specially interested in temperance education, and the teachers without whose aid nothing can be satisfactorily accomplished, should get together, ascertain what ground of belief they have in common, and work together on that ground in the public schools, leaving disputed questions to be settled elsewhere. In the public schools should be taught only those facts and opinions which can not be controverted.

With the nonessentials omitted much more work can be done, and done better. The matter relating to alcohol and narcotics which is now taught throughout the entire course can be taught just as thoroughly and with added interest in half the time now consumed. The teacher should have perfect freedom as to method. He should not be required to discuss the effects of alcohol or other substances in connection with each function or system of organs. If he can teach better with the text, let him teach that way. If he can teach better without it he should be free to do so. He should be allowed to exercise his judgment in this as in other studies, as to whether the pupil understands it and may safely discontinue it. Comprehension of the subject and not number of lessons should be the standard of graduation from it. Thus the pupil will be freed from the senseless repetition that makes an otherwise pleasant study hateful. To render these changes possible our state law should be amended, and all interested in true temperance should lend their influence to that end.

F THE CONNECTICUT LAW

In its preliminary report your committee said:[1] "We are interested in the recent changes effected in the law in the state of Connecticut, and look with favor on its present provisions, but, before recommending similar specific changes in our law, we deem it wise to allow a reasonable time to elapse for observation of the working and results of that law."

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[1] *See* University of the State of New York. High School Bul. 17, p.761.

The Connecticut law reads as follows:

Act approved May 29, 1901. Public Acts, 1901, ch. 81

§ 1 The effects of alcohol and narcotics on health, and especially on character, shall be taught in connection with hygiene, as a regular branch of study, to all pupils above the third grade in all graded public schools, except public high schools.

§ 2 Suitable textbooks of physiology and hygiene, which explain the effects of alcohol and narcotics on the human system, shall be used in grades above the fifth in all graded public schools, except public high schools.

§ 3 The provisions of sections 1 and 2 of this act shall apply, in ungraded public schools, to classes corresponding to the grades designated in said sections.

§ 4 All normal schools and teachers training schools shall give instruction in the subjects prescribed in section 1 of this act, and in the best methods of teaching such subjects.

§ 5 No certificate to teach in grades above the third shall be granted to any person who has not passed a satisfactory examination in the subjects prescribed in section 1 of this act.

§ 6 If it shall be satisfactorily proven to the comptroller that any town or district, having pupils above the third grade, has failed to meet the requirements of this act, such failure shall be deemed sufficient cause for withholding, in whole or part, school dividends which such town or district would be entitled to receive.

§ 7 Chapter clvii of the Public Acts of 1893, and sections 2100 and 2141 of the General Statutes, are hereby repealed.

To ascertain the practical working of this law which became operative Sep. 1, 1902, the following circular letter was sent to the superintendents of schools in nine of the larger cities of Connecticut. That part of their answers bearing on the questions is given below:

Buffalo N. Y., Sep. 29, 1903

DEAR SIR: The New York State Science Teachers Association is now endeavoring to secure a more rational law regarding the teaching of stimulants and narcotics in our common schools. Knowing that you are working under the action of a new and less strenuous act, I take the liberty of inquiring whether the new law is more, or less, satisfactory than the old and in what respects. How does it affect results? Do you see any change in the attitude of teachers or pupils toward the subject? Does your experience suggest any further modification by which the present Connecticut law could be improved?

Very truly yours

[*Signed*] I. P. BISHOP

President State Science Teachers Association

1 The Connecticut law to which you refer has greatly modified the attitude of superintendents, principals and teachers toward the teaching of socalled temperance physiology . . . As evidence of the improved attitude of school people toward the subject I will state that there have been frequent calls throughout the state for lectures and illustrative lessons on subject-matter and methods of physiological instruction. Our state normal schools, more especially those at New Britain and Willimantic, both of which had before 1900 ignored the subject and the law, are now giving the subject serious attention. The temperance people count this a great gain.

I know of no respect in which the Connecticut Law should be changed nor have I heard any suggestion on that point. As far as I am aware, the school people and the temperance people are satisfied to let the present law stand.

2 I think that the new law regarding the teaching of temperance physiology is working as well, certainly, as the old one.

3 It is a great improvement over the old one. It does not demand the impossible as the old law did in requiring reading book instruction on the subject in the kindergarten and primary grades. It gives a more rational apportionment of the time to be given to the oral and textbook instruction. It commands the respect of the teacher in a much greater degree than the old law did as it makes the study of hygiene the basis for temperance instruction. It has driven the untruthful and unscientific textbook from the Connecticut market. It has stimulated the making of better textbooks on the subject.

I have no modifications to suggest to the present law. If we must have one, the present Connecticut Law is all right as far as I know. Our teachers are interested in the subject and would teach it to the best of their ability without law. Drawing, history, literature, and manual training have never been legislated into our curriculum.

4 The law is the best that I know of and there is no reason why it should not be a success if the teachers will do their part. As yet I have not seen any change in the attitude of teachers or pupils toward the subject, but in time there must be. The law is such an advance over the old one that I expect to see an entire change in the attitude of teachers and pupils toward this important subject. I expect also to see a much better series of textbooks published than we have had during the past.

5 I believe that the present law is better than the old law. I believe that it would be still better if teachers could be left to themselves in regard to when and how much of the temperance idea should be introduced into school work. A law requiring

formal instructions in temperance and morals is of doubtful utility.

6 Our law was prepared with much care and after thorough discussion and works to our satisfaction so far. We consider the change a decided benefit so far as the impressions on the child's mind are concerned. My worst trouble has been to get hold of the right textbook on the subject.

7 The present Connecticut law is very satisfactory. I am unable to make comparison since the only effect it has had on our work is to remove compulsory instruction from the first three grades.

8 We find conditions in respect to the teaching of physiology, and especially the effects of stimulants and narcotics, changed for the better under the new law. This change for the better is brought about partly through the fact that we no longer have to begin to teach with a textbook in the hands of children in so low a grade as formerly. The original law was, in my judgment, absurd in that it required the placing of a textbook in physiology—with the due amount of space given to the treatment of stimulants and narcotics—in the hands of children having no textbooks in any other subjects. We now place books in this subject in the hands of the children in the fifth grade, that is, the fifth year in school. The teachers, and so far as I know, the pupils, are much pleased at the change and I am confident that the merit and efficiency of the work have been improved.

9 Replying to your letter of recent date will say that we have been working under the new law concerning stimulants and narcotics for one year. In my judgment the law is very much more satisfactory than the preceding one, for the following reasons. More liberty is allowed in the use of textbooks. We shall be able to supply ourselves with textbooks that do not make overstatements and leave wrong impressions upon the mind. There is larger latitude given the teachers in their work.

I believe that teachers are better pleased with the present law than with the old one, for the reason that, in the lower grades, not nearly as much is required of them. I do not think any further modification of the present law is needed although we shall have to summer and winter with it two or three years to determine that positively. So far as results gained are concerned it is very much too early to decide.

I question very much whether our temperance friends will fully realize the results that they have anticipated from any law; still we can but hope that impressions will be made that will influence for good all future life.

I am perfectly satisfied with the present law so far as I have observed it.

The extracts quoted above confirm your committee in the favorable opinion of the Connecticut law expressed in our preliminary report.

This law was passed after meeting the approval of the Connecticut temperance organizations and educational authorities. Why should not similar cooperation be practicable in the State of New York?

G APPENDIX

Modifications of the preliminary report of 1901

1 Fothergill's *Practitioner's Handbook of Treatment* was quoted on p. 746 and 747. The quotation is correct; likewise the year of publication. But, through inadvertence in writing and proof reading, the edition is said to be the 11th instead of the 4th; the number 688 designates the number of pages in the volume; the passage quoted on p. 746 is from p. 34; and the title should have included the information that this edition has been "edited and in great part rewritten by Murrell."

2 On p. 747 respecting the textbook of Steele it was shown experimentally as early as 1870 that alcohol is largely oxidized in the body. Subsequent experiments in 1875 and 1883 confirmed this fact beyond reasonable doubt. Steele's *Hygienic Physiology* written in 1884 teaches that alcohol is eliminated unchanged from the body without oxidation. In 1889, 14 years after the nearly complete oxidation of alcohol in the body had been conclusively proved (1875), the book received the indorsement of the Woman's Christian Temperance Union and bore this indorsement without alteration of the objectionable statement till 1900. We are credibly informed that the change, conceding the partial oxidation of alcohol in the body was made in 1900, but have not found it in any edition earlier than the one having date of 1901. The edition of that year concedes the partial oxidation of alcohol in the body. When our preliminary report was issued, Dec. 28, 1901, the change had not been brought to our attention.

At the time of its indorsement by the Woman's Christian Temperance Union and for several years after, Steele's textbook was probably more widely used in New York State than any other

school physiology. The erroneous statement, therefore, through its indorsement, secured extensive dissemination and credence.

3 On p. 758, in the prelude to one of the queries sent to teachers by a member of the committee, occurs the following: "Prof. Atwater's experiments seem to prove conclusively that alcohol in small quantity can be used like sugar, starch and fat for generating heat and muscular energy." In so far as the committee as a whole may be held responsible for the above it is proper to say that the words "seem to prove conclusively" should have been "render it probable." See Atwater's guarded declarations on the subject in *Physiological Aspects of the Liquor Problem*, volume 2, pages 269, 278, 279. On 279 he states explicitly that proof of the conversion of alcohol into muscular energy in no way proves the desirability of alcohol for such a purpose.

4 On p. 750, the phrase, "Youths, say under 21, should abstain altogether from alcohol," has been objected to as a "specious plea for moderate drinking" after the age named. We wish to say, emphatically, that nothing in that report, or in the present, is intended as a general recommendation that alcoholic beverages be used even by adults. Nor, particularly, is the reprobation of their use by youths, say under 21, to be construed as advising or even condoning their use on attaining that age. That age is specified because it seems best to discriminate between the boy who should not drink at all and the man who in our opinion, may drink under certain conditions. At 21 the individual ceases to be an infant or minor in the eyes of the law; he attains his majority. With respect to alcoholic beverages we believe he may wisely and prudently continue to abstain at least till of middle age.

Mrs Cora Dodson Graham—In the latter part of October (27) the chairman of your committee on stimulants and narcotics, invited me to take part in the discussion of the report which his committee would make at this time. In my reply, after stating that my official, social and home duties naturally demanded much time, I accepted the invitation on condition that I had the report at least two weeks in advance of the discussion so that I might work on it as time permitted. You have heard of the disadvan-

tages under which his committee has labored, and I think it but just to me and the views I present, to say that not one page of the report had been received by me till Wednesday afternoon of last week, and then but three pages, and that not till yesterday afternoon at four o'clock five pages more of the report. Since the receipt of yesterday's portion of your committee's report, many unavoidable interruptions have occurred, and as you should be generous with them, I ask only the same courtesy for myself, one of your guests of the hour, in case I should occupy a little more than my allotted time, as I have not been able to rewrite my paper and bring it thus into exact time.

Let me say, however, that the two volumes of the subcommittee of the Committee of Fifty have been carefully read and annotated by me, and that I have been thoroughly familiar with the *New Century Physiologies* since their publication two years ago, and that I heartily indorse them. No textbook, on any subject, has yet pleased every one.

As your committee on stimulants and narcotics base their report on the "Conclusions" of the subcommittee's report of the Committee of Fifty [1: XIX–XXII]—in fact, attach to them so much importance as to include them as an appendix to their own report, I wish to call your attention to a few facts accessible to any who may study the situation.

The subcommittee states that its object has been "to ascertain the effects of the occasional or habitual use of a moderate quantity of wine, beer or spirits upon the health and working powers of man" [1: XIX]. That was undoubtedly one of the reasons for the investigation made and data collected, but another reason found on page 45 [v. 1] gives the underlying principle of the origin of this self-appointed Committee of Fifty. In speaking of the failure "of the attempt" to remove the study of physiology, hygiene, etc. from the Massachusetts schools, this committee declares that "In this struggle the Committee of Fifty should speak with no uncertain voice." Again this reason for compilation is found in some of the responses received from European authorities, who knew nothing of this phase of our educational laws,

save what the compilers wrote them. Professor C. von Voit, Munich, wrote to the committee, Dec. 11, 1898, "You were so kind as to inform me of a movement which aims to calm the exaggerated agitation of the temperance questions, etc." Another writer said [1: 89–90], "I was quite shocked when I read in Hodge's letter which he wrote at the request of the Committee of Fifty, that in the primary and middle grades every child from 6–17 years is instructed 250 hours in the physiology of alcohol." He had been told what was not true. A glance at the various state laws in volume 1 [p. 95–125] will show even the casual student that the word lessons not hours, is invariably used. The study in question is not the physiology of alcohol, but physiology and general hygiene, only about $\frac{1}{5}$ of the whole being instruction as to the nature and effects of alcoholic drinks and other narcotics. There is no requirement of 250 hours of instruction even in the whole subject of physiology and hygiene. Even the most stringent law [Illinois] requires but 330 lessons, not hours, which is a very different matter. There is no legal requirement as to the length of lessons in this subject. 10 minutes is the average length of any lesson in the first primary year, 15 minutes in the second and third years, and 30 minutes in grades above the primary. Therefore, the 330 lessons required for the study of physiology and hygiene take about 140 hours in all of a probable school attendance of 7200 hours, less than 2% of the whole. Only one-fifth of even this small amount of time need be given to temperance matter, that is, about 28 hours in 9 years, or an average of $3\frac{1}{9}$ hours a year. This is a case of simple arithmetic, and there is no cause for a false statement such as was sent to European scientists—unless evidence against our system of education was desired by the Committee of Fifty. This cause can partially explain the discrepancies between the "Conclusions" which your committee have distributed in the audience this afternoon, and the investigations made by some of the experimenters under the direction of, and whose funds were supplied by, the Committee of Fifty. For these experiments I have warm words of praise and find them a most valuable addition to the research material on the alcohol question.

My only regret is, that these experimenters, scientists, should lend themselves as a cloak to the Committee of Fifty in shielding the real purpose they had in organizing themselves into such a committee. But since they have unintentionally put into the hands of those who uphold the laws which they seek to weaken, such valuable testimony and scientific data which prove the wisdom of our state and national educational laws, we can afford to be generous.

Permit me, briefly, to illustrate some of the discrepancies referred to a few minutes ago.

Paragraph 6, first two sentences read as follows: "The question as to whether a given alcoholic drink is a food or a poison is one that can not be answered by any short comprehensive formula. In moderate quantities, beer, wine and diluted whiskey are, in a certain sense, foods; etc." In volume 1, page 83, A. Fick, of Wurzburg, writes, Nov. 3, 1897, "I consider instruction upon the effects of alcohol very advantageous. I believe that this instruction must lay special stress upon the undeniable truth that alcohol is under no conditions and in no amount beneficial to the healthy body."

Paragraph 7, first line and a half: "Alcoholic drinks in moderate quantities may be used as restoratives in fatigue after work is done." In opposition to this, I would quote one of the Committee of Fifty's own experimenters, John J. Abel M. D. who writes as follows:[1] "It will be seen that alcohol is not found by psychologists to increase the quantity or vigor of mental operations; in fact, it clearly tends to lessen the power of clear and consecutive reasoning. In many respects, its action on the higher functions of the mind resembles that of fatigue of the brain; though with this action is associated a tendency to greater motor energy and ease."

Paragraph 8. If your committee on stimulants and narcotics had carefully read this paragraph, had analyzed the "Cambridge Statement" [1:18], and studied the *New Century Physiologies*, as well as read the testimony of those whose letters are incorporated in the subcommittee's report, I do not believe that you

[1]Pharmacological Action of Ethyl Alcohol. 11:141.

would have heard them call this subcommittee's investigations "fair and unprejudiced."[1]

The Cambridge statement misrepresents the attitude of the modern indorsed textbooks, and then criticizes this assumed position. The subcommittee tries to lessen the real scientific rank of those Europeans who favor total abstinence or scientific teaching of the nature and effects of alcohol and other narcotics in relation to the subjects of physiology and hygiene [v. 1].

Has your committee read on page 3 of volume 1, the statement which the subcommittee of the Committee of Fifty makes (in their criticism of textbooks) to the effect that they "shall make but little reference to recent investigations which have not yet found their way into standard (medical) textbooks," and can your committee will consider the subcommittee "fair and nonpartizan." when it thus compares the up to date indorsed textbooks with old medical books, and because of the difference found, declare modern textbooks inaccurate, though the latter are in harmony with the results of modern experimenters? Time forbids many more citations which would throw light on this committee and its work.

The report prepared by Dr H. P. Bowditch of Boston, and Prof. C. F. Hodge of Worcester Mass., on the present instruction on the physiologic action of alcohol, is believed to be a correct representation of the facts, and to justify the conclusions that much of the so called scientific temperance instruction in the public schools is unscientific and undesirable. It is not in accord with the opinions of the leading physiologists of Europe as shown by the statement printed on page 18 of volume 1 of this report. This appears to us to be a matter of grave importance.

Paragraphs 9 and 10 will be answered elsewhere in my discussion, though I shall say in passing (in reference to paragraph 10), that a body of scientists weaken their arguments when they show they are ignorant concerning the subjects they are supposed to "discuss."

The one plan which has always been favored and executed in the indorsed books, has been the teaching of the nature and effect of alcohol and other narcotics in connection with the various

[1] *Pharmacological* Action of Ethyl Alcohol. 11:141.

divisions of physiology and hygiene,[1] instead of throwing all temperance matter into a few pages at the back or front of textbooks, as advocated by your own committee, I believe.

So far, I have heard no argument against the law itself, which can stand fire. The point which disturbs the Committee of Fifty and your own committee too, is that the children are taught today that total abstinence rests on a scientific basis. Why do they not confine their attacks to modern investigators who have handed down this fact from their laboratories? The law simply states that the nature of alcoholic drinks and other narcotics shall be taught, leaving to experts to declare what that nature is. I would like to ask how many of the teachers present are personally acquainted with the text of the Ainsworth school physiology law of May 27, 1896. The law does not specify the length of lessons, nor in what way the number of lessons shall be arranged in the curriculum, whether by lesson groups, or singly or otherwise. The arguments against the use of textbooks are specious ones, and so, illogical. Textbooks in the hands of good teachers—and New York has many such—are aids only, and never can become their masters. Such technical knowledge of physiology and hygiene, the nature and effect of alcohol and other narcotics, are not subjects which so readily become "common knowledge" as the facts in geography, etc., and so the conscientious teacher welcomes as a friend in need, an up to date textbook on these subjects which bear so vital a relation to the child's life.

As has just been stated, textbooks serve as one source of information, saving the conscientious teacher much work in gathering together the needed information for teaching the subject intelligently to her class, and thus share, somewhat, the responsibility toward her pupils for correct study material.

The report says that the teacher regards the textbooks as ill-arranged, partizan, exaggerated or inaccurate. I ask, "To what textbooks do they refer?" If teachers are using the textbooks printed in the last century, and many are, it is possible that, in

[1] *See* Ainsworth school physiology law, 1896, §1, ¶19.

the light of scientific knowledge and skill of today, some of the above criticisms may be true, however well the books served their purpose in their own time. I have asked for reviews of the *New Century Physiologies,* 1901, for instance, by volume and page, which shall prove the above criticisms just and well founded. The offer is still open.

Permit me to read a paragraph from the reply to the Committee of Fifty, advance sheets of which reached me this morning from the New York State Central Committee, which is in harmony with what I have just claimed:

> We respectfully recommend that the subcommittee make a careful study of the experimental evidence on the alcohol question brought out by their own investigators (Abbott, Chittenden, Hodge, Welch, Abel and Atwater), compare this with the work of other investigators in these fields, and this with the teaching of what they call their standard medical textbooks. When this is done, they will find that the "disadjustment" of which they complain is between recent experimental findings and the old medical literature into which the results of this recent work have not yet "found their way." The indorsed textbooks are in harmony with recent evidence rather than with old opinion.[1]

Those who advocate the theory that all physiology teaching should be confined to the upper, intermediate and grammar grades, lose sight of that great underlying principle in education so strongly expressed in the sentence: "Education is not a preparation for life, education is life!" The object of the study of physiology and hygiene is to influence the children's habits, of which new ones are forming every year. To do this, the study must run through the habit-forming years, and, like other progressive branches, be graded to the child's growing comprehension; in this way there is no "senseless repetition." It is often true that the teacher's influence is the only good influence under which the child is ever brought. How important it is, then, that she should not delay teaching him facts about his body and its care till he shall have reached the intermediate grades and have already formed

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[1] Reply to the physiologic subcommittee of the Committee of Fifty, p.17. [Advance sheets]

bad habits which might have been avoided by an honest presentation of the required subjects.

As Dr P. A. Levene of New York expresses it in the report of the Committee of Fifty, "All we can tell to the (college) student, we can also tell to the primary boy, if we know how." [1: 59–60] The textbooks aid the teacher in knowing "how." Every good catholic in this audience appreciates the value his church places on the early influences on a child's whole life.

For this reason, if for no other, New York State can not favor the present Connecticut temperance education law which became operative Sep. 1, 1902, little more than a year ago. The real results of teaching under it can not, of course as yet be determined. But any law which deprives the child of instruction in the subject of physiology and hygiene on the same basis as other required studies in the curriculum till the fourth or fifth year of school, and makes such instruction even then for two years but oral and also takes the study from the high school boys and girls, is a weakling among laws, and defeats the very purpose for which it was made.

The committee speaks of antagonism. It is possible that some of you feel that way toward us, but our attitude is not one of antagonism. Too many of us have been teachers, are teachers, or are too intimately, in other ways, connected with school problems, to feel other than closely bound to you. We believe—know—that too large a number of teachers do not thoroughly understand the law and its requirements; are given prejudiced views in relation to the whole subject by those who should be their leaders in giving the law a fair test; are compelled by school boards or others to use antiquated textbooks and poor apparatus; and we are not surprised that those of you who are teaching under such conditions, should desire a change "in the present scheme of education." We are not in favor of the present "scheme," and desire a change too, but perhaps not the same kind of a change as your committee means, and I wish to make the suggestion that the logical action to be taken by your association in consequence of the fact that there is so much misunderstanding and misconception

on the part of various people regarding the true condition of affairs, that you move the appointment of a joint committee of your representative members on the one hand, and an equal number of representative members of my organization. I believe I can assure you that my state organization would act in such a committee as that. Your committee made an investigation two years ago, and arrived at certain conclusions. The New York State Central Committee made an investigation the same year and received entirely different results. Thus it will always be, I believe, till we do study this question together. Till such action is taken, and the law is tested under the best possible conditions, it would be wise as well as politic, to make no motion looking toward an amendment of the law. If under the best possible conditions the law should prove by its "fruit" its inefficiency to bring about the result for which it was called into existence, you could find no one readier than the temperance people in working for its amendment. Till such proof is given, however, it will be better to give the law an honest test and thus prove your sincerity as to the results for which your committee is working. The New York State Woman's Christian Temperance Union contains about as many members as there are total number of teachers in the State, and we are but one organization among others interested in this particular law, to say nothing of the great unorganized body back of us all, the people, whose law this is.[1]

Tuesday afternoon

ZOOLOGY IN THE HIGH SCHOOL

BY GEORGE H. HUDSON, PLATTSBURG NORMAL SCHOOL

The purpose of the study of zoology and its value in a school curriculum are things which change with change in our environment.

Speaking 10,000 years ago I should have insisted that the zoologic knowledge of greatest worth was that which dealt with

[1] The above discussion was based on the second preliminary report of the committee on stimulants and narcotics, and with the latter, formed a part of the "proceedings" of the association. The final report was not presented at that time, nor acted on by the association as a whole.

the manners and habits of our four-footed and other animal relatives. Important questions of those days were: how can I most successfully capture fish, fowl, or beast for my food; what can the animals give me of their store of wisdom; will feeding a troublesome shark with the baby make the former a member of the family and so secure its father from attack; and what is one to do when he accidentally meets a saber-toothed tiger, and discovers that his most potent charm is no longer hanging from his neck?

Three thousand years later my efforts would have been to persuade you that to have a sheep or ox so used to the presence of man that it might easily be killed with a club when desired, was more practical if not more noble than the hunt or the pitfall; and that having a scapegoat for sins and diseases where one could place hands on him without delay was a distinct and additional advantage. At that age of the world's progress we no doubt would have discussed the comparative value of driving the scapegoat away for many miles to insure against return, or the quicker and easier dispatch to a country from which return was still more doubtful, and we probably should have ended by making a compromise like that practised in Leviticus. Another important question would have been whether or not the ground for the annual harvest could be as thoroughly fertilized (in the old sense) by killing and planting a goat, as by killing and planting a man, providing the same ceremony was carefully performed. Later I might have asked for a more careful presentation of the anatomy of the contents of the coelom in its relation to the character of the coming season and to coming tribal and personal events, and I should have pointed out the need to teach the special dwelling place of the spirit, and the location of the rooms in the body usually occupied by unbidden ghosts, that they might be successfully driven therefrom by disagreeable internal or external applications.

After the time of Hippocrates, great stress would have been placed on the need of a better knowledge of the nature and cause of disease, and I should have insisted that it was a teacher's great privilege and duty to bring the general public to appreciate the

fact that broken bones could be more successfully treated by a competent physician than by prayers or gifts to the gods. I need go no further. You can fill in the introduction of collecting, using analytic keys, classifying, dissecting and sectioning. That is about where we are now, but the science of biology has swept on to new and greater things. The proper study of animal or plant now yields us knowledge of the great laws that govern all growth and all development. It has read for us the long past history of the race with a certainty far surpassing any tradition or treasured lore of any people that ever lived on earth. It goes further still, and not one whit too strong are the lines of Tennyson,

> Flower in the crannied wall,
> I plucked you out of the crannies;—
> Hold you here, root and all in my hand,
> Little flower—but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is.

From the primitive gifts of food and clothing we have passed to gifts relating to our mental and ethical development and now we ought to teach the new gifts, that our students may begin to live a life for the higher things in it.

You may say that the former threshing has in most cases left the greater part of the grain still in the straw; that a fly or mosquito may be every bit as dangerous as a tiger; that there are animals yet to tame and turn to our use as servants or companions; that the field of animal habit and mental attitude is but lately opened; that the need to teach the public that broken bones and contagious diseases are best dealt with by an educated physician, is as great as ever; and that too few know that the best of all charms to ward off disease is the charm of absolute cleanliness. These things are readily granted, but I point to the law of Cope and Hyatt, the law of acceleration, and I congratulate you on the fact that something is now done along these lines in the earlier years of school life under the name of "nature study."

A sound zoology has so much to yield that it should be given every student who secures a high school education, but today it absolutely demands that maturity of mind that only the last year of the high school can give. This is the year that should be devoted to it. Historically physics and chemistry preceded it,

and logically they must of necessity precede it. They are its foundation stones. Digestion, osmosis, assimilation, combustion and other fundamental life processes can not be properly understood without them. To grasp the real value of the study requires a mind already trained in the ability to observe and interpret facts.

We are living in a very peculiar period of the world's history. The foundations of old faiths have been distinctly weakened and there seems to be no new bread for the hungry. Of that reasoning animal supposed to bear the royal stamp of God's own image, thousands and tens of thousands, yes millions, are led like sheep after new faiths with which to quiet an uneasy mind, or new patent nostrums to heal some diseased portion of their physical being. It is a sorry commentary on our system of education if we call *these* people educated. With the sciences well taught a student should begin to grasp the idea of the comparative value of evidence. He will come to see that faith is the more valuable, the more complete and trustworthy the evidence on which it is based till faith passes the boundary set by definition and becomes knowledge. Few realize how much of a scientist's work is done through faith. Many scientists still hold that the evidence for molecules and atoms is far from complete. Some even call in question such laws as those of the indestructibility of matter and the conservation of energy. We perhaps can not yet give conclusive proof that the newly discovered laws of nature are unchanging but we have faith that they are, and it is on a faith of this type that we build a steel bridge, and a sound civilization. Teach that God's greatest gift to man is the power to discover the constant in the seemingly inconstant, that there are things in this world on which we *can* depend, it may help us to make men and women on whom we can also depend. To my mind there are many scientific courses that fail to place this stamp on the material that comes from the mill, and I believe that for this age it is the stamp of greatest worth.

Other reasons for placing the study of zoology last in the high school course, such as the necessary and valuable study of reproduction, would lead me also to advocate the arrangement of the course itself so as to have it begin with one celled forms of life and proceed along phylogenic lines to higher types. If one says

this is not the historical method, let him reflect that we do not get all our education in the school. We have had the historical method. We studied mankind first in the person of mother or nurse, our next animal was very likely a dog, cat or horse, and from these we no doubt passed to birds. It may be true that our blanks for the epitome of our ascent might have been filled in a little more fully and this we may now expect our "nature study" to do. Through the help of the law of acceleration our high school students have arrived at modern times, and there remains no reason why they may not take up their zoology from the higher stand of animal history. If you begin with the amoeba you may get so interested in the history of change in form and the laws involved that you may not have time enough left for the dissection of your cat and if you do not I shall say "so much the better." I have taught biology for more than 15 years and have dissected cats, rats and frogs, but I feel that *the dissection of the simpler invertebrates in high school work pays much better.* Students who have done good invertebrate dissection will be glad to avail themselves of the deeper knowledge to be gained through vertebrate dissection, and they will be prepared for such work. This they should have in their college course. In my earlier work I have seen girls faint when a snake was brought into class, and I have seen them made sick over the dissection of a frog. I now feel that I have made a change for the better in my work. In my last class there was a young lady with some form of heart disease, as certified to by her physician. She was very sympathetic, and had an inherited and well developed horror of worms and insects. She believed that her course in biology was going to be a source of constant torture to her. Unknown to the rest of the class she took pains to wash her rhizopods and infusorians back into the jar from which they were taken, yet Volvox gave her pleasure even though in mounting she had crushed some colonies with the cover glass. Hydra became a marvelous creature, and she did not object to giving one a dose of methyl blue in order to obtain good nematocysts for drawing. The reproduction by budding was strange and still more strange the production of so many small spermatozoids and the larger ovum. The body came to have a meaning, and the variety given it by Eudendrium, Clava,

Campanularia, Sertularia, Obelia, Aurelia, Dyphes, the sea anemones and the corals was a new and wonderful story, and each form in turn said "evolution" in clear and unmistakable accents. We had living sea anemones and corals and we have them still. The keeping of a salt-water aquarium for a few weeks is not a very difficult matter and will well repay the time and expense given it. The young lady who could not bear to touch a worm came voluntarily to stroke one to feel its setae, helped to dissect one, and made a drawing of its internal anatomy. This monoecious form, which was so strangely provided with the means of securing a cross inheritance for its young, seemed to have had a stamp of dignity, purity, or divinity given it, and a review of Darwin's work on the group served to emphasize its importance in the world's work. The study of Nereis and of parapodia followed, and after this the students collected living myriapods, studied Lithobius and then passed to the dissection of the lobster. Particular stress was here placed on the modifications of the appendages, and these were compared with those of other members of the group and with Beecher's restoration of Triarthrus beckii. The reproduction of the form was given and the modification of embryonic stages noted.

It was a matter of pleasure to see how the study of the worm had enabled the students to grasp so quickly the essentials of the anatomy of the lobster, and to note how much their pleasure had been enhanced through the possession of a foundation for the exercise of apperception. This logical sequence developed an interest that practically banished from the work all painful or disagreeable impressions. Taken this way, one develops that power of judgment on the evidence before one, which the race needs for its redemption. Taken from the highest forms down you may impress the facts on the authority of the text or on your own *ipse dixit,* but the field will from the start be so complex for the student that not for a moment will he dare let go the hand of his guide. This course tends to develop that type of mind that will follow any other leader, and the majority of those so taught will for ever quote teacher or text as their authority at least so far as interpretation is concerned. In place of any but the simplest vertebrate dissection it were better to give enough

vertebrate histology to show that complex as the body is, it is still built as are the simpler types and is by no means an insoluble enigma.

Lastly let me urge the necessity of teaching zoology as a science. One may teach chemistry in order to impart the very valuable fact that hydrochloric acid dissolves zinc. He may have a higher ambition and desire to make his students the happier for the rest of their lives by showing them that the ratio between the weight of zinc used and the weight of hydrogen obtained never varies. Why do we teach that the decomposition of water yields weights of oxygen and hydrogen in the ratio of very nearly eight to one; that the ratio expressed in volumes is one to two; and that three volumes of hydrogen and one of nitrogen yield two volumes of ammonia? These things are not introduced for their interest as facts, but for a clear and definite purpose, and that purpose is to demonstrate the laws of definite, multiple, equivalent, and gas-volumetric proportions, and we pass to other laws with the same careful and purposeful selection of facts. Are our facts in zoology chosen for a similar purpose? But the laws in chemistry are not the final aim of the study. They are given for a still higher purpose, and that is to lead our students through that mental process which gave us our conception of the molecule, the ion, the atom and the corpuscle. It is possible that these concepts may be changed, but whether changed or not they have achieved something for the race. By their aid we have been enabled to postulate new compounds and then make them. They have made modern chemistry what it is today and modern chemistry has been a very important factor in our recent progress as a race. A process of thought that can achieve such grand results is a process of thought that we wish our children to be able to take and follow by themselves. So followed it will make our children appreciate what true evidence is, give them the power to use it, and so build for them a character. I have not spoken for that so called chemistry which simply tries to follow a certain fixed process in order to discover what the teacher has dissolved in a bottle of water. That course is but another to help make obedient followers.

Now if we would have our zoology take higher rank as a science, we must have our facts introduced not alone for their interest

or value *as facts* but for the purpose of demonstrating zoologic or biologic laws. And lastly we must not be content with the mere presentation of the law but must use it in helping us to grasp the greatest and grandest of all modern concepts, the concept of evolution. If we can give our course this character it will be worthy the name of science and we shall succeed in making for a type of civilization that is distinctly higher than any the world has yet seen.

To briefly recapitulate—I would place zoology in the last year of the high school course, leave to the department of nature study much of the material formerly taught under this head, begin the work with unicellular forms, have most or all the dissections confined to invertebrate forms, use the facts in a systematic way to demonstrate laws, so use the laws that the students may adequately grasp the concept of evolution, and I should point to that concept as the corner stone of a new era in the social and ethical development of man.

Prof. W. M. Smallwood—We have come to recognize the value of chemistry and physics and give to each of them a full year in the high school curriculum. We hope that the time is soon coming when the same recognition will be given to the biologic sciences. As to the manner of teaching zoology there are many different opinions. In Syracuse University in the beginning course, we find that the students have to be taught to see things and we usually begin with one of the larger organisms, such as the frog and gradually work down to the unicellular forms. While I grant that a study of Protozoa creates an interest at the very outset, yet the student can hardly derive much from this study because he has not been trained to observe and compare.

So far as the idea of evolution is concerned, it really matters little how the course is conducted as each general phylum must be taken up as a unit. This is specially so since the authorities can not agree as to the phylogenetic relationships.

Let us emphasize the ecology work in the high school and place less stress on the dissections. This will remove much of the just opposition to the introduction of up to date zoology and, I believe, will accomplish an equivalent amount of training.

DIAPHRAGM APPARATUS

BY BURT G. WILDER, CORNELL UNIVERSITY

Prof. Burt G. Wilder of Cornell University illustrated the action of the diaphragm in respiration by means of an apparatus consisting of a bell jar welted at the larger end; this end is closed by a thick rubber sheet; the smaller end is closed by a rubber cork with two holes; through one hole passes the glass tube representing the trachea to which is attached a rubber balloon or the lungs of a cat or other small mammal; the other hole is covered by a bit of thin rubber acting as a valve. When the rubber diaphragm is forced up into the jar by pressure on a convex mass, e. g. half of a croquet ball, the displaced air escapes through the hole guarded by the valve; when the pressure is removed the diaphragm contracts, becomes less convex, and the formation of a vacuum is prevented by the entry of air through the trachea and the expansion of the lungs.

Essentially the same apparatus was first exhibited before the Boston Society of Natural History in 1878 and described in its *Proceedings*, volume 19, page 337. It was figured in Wilder and Gage's *Anatomical Technology* in 1882. With this earlier form the initial escape of air from the jar in order to permit the ascent of the diaphragm was provided for either by removing the cork or by having the cork perforated by a second tube to the upper (extrathoracic) end of which was attached a bit of rubber tubing controlled by the fingers or a pinchcock; the rubber value was suggested in 1892 by E. C. Stillwell, janitor of the department of physiology, etc. The bell jar with a long and wide neck was made by Whitall, Tatum & Co.

Wednesday morning, Dec. 30

REPORT OF COMMITTEE APPOINTED TO PREPARE A SYLLABUS FOR SECOND YEAR PHYSICS

BY E. R. VON-NARDROFF, CHAIRMAN ERASMUS HALL HIGH SCHOOL BROOKLYN

As elements in the course we contemplate problems, demonstrations, discussions and laboratory exercises. No one of these elements is to be given first place, but each is to be subordinated

to a general logical plan. Our plan has been to develop all the important material that experience and inquiry have shown is usually omitted from a first year course, though presented in many high school textbooks. In addition we have planned to include a few other elementary topics, either because of their importance or peculiar interest, or for the purpose of rounding out the course. In choosing laboratory experiments we have specially considered the lesson in pure physics they teach, and have sought to exclude those that are purely technical in character or that tend to conceal the physics involved behind a mere mathematical maze. Our plan, too, has been to present a course in pure physics rather than a preparatory course for mechanical or electrical engineering.

It is intended that a large proportion of the topics mentioned should be covered in one year, allowing a minimum of five periods a week, two of which are to be spent in the laboratory. Nearly all the demonstrations mentioned, or their equivalent, should also be covered. This means a great amount of constant preparation on the part of the teacher; also much skill. About 30 laboratory exercises should be performed, and to preserve proportion in the course, each division should be represented by at least two exercises. Problems may be arranged using the laboratory exercises as a basis, but it is suggested that it is desirable not to so overload the course with problems as to leave little or no time for full discussions of the subject in its qualitative and practical aspects.

At present no textbook adapted to the course seems available, and so the teacher will have to depend largely on mimeographed notes. For the laboratory exercises, however, much trouble may be saved by placing in the laboratory the leading laboratory manuals.

The following may be recommended: *Practical Physics* 3 volumes by Stewart & Gee, published by Macmillan; *Physical Measurements* by Kohlrausch, published by Appleton; *Systematic Electrical Measurements* by Parker, published by Spon & Chamberlain; *A Laboratory Manual of Physics and Applied Electricity*, 1st volume, by E. L. Nichols, published by Macmillan; *A Manual of Experiments in Physics* by Ames & Bliss, published by American Book Co.; also many others will be found available.

Outline of course

1 Properties of matter and molecular physics

TOPICS	DEMONSTRATIONS	LABORATORY EXERCISES
Magnitude	....	1 Estimations of $\frac{1}{10}$s and $\frac{1}{100}$s 2 Micrometer caliper 3 Spherometer, lens 4 Optical lever $\frac{1}{10000}$ inch
Weight.............	....	5 Accurate weight, Gauss—swings
Ductility...........	Draw down thick wire to thin	
Malleability........	Roll tin Transparency of gold leaf	
Viscosity...........	Sealing wax	
Crystallization	Sulfur from fusion Alum from solution Iodine by sublimation	
Surface tension.....	....	6 Surface tension of soap water by rectangle and balance
Capillarity	Law of dia.—tubes Law of distance—plates	
Diffusion...........	....	7 Law of efflux of gases, H and Co_2
Osmosis	Sugar solution Coal gas	
Tenacity	....	8 Law of transverse breaking strength

2 Mechanics of solids, liquids and gases

Absolute units of force		
Erg, foot-poundal, etc.		
Moment of inertia..	....	9 Ringsand bars (Kelvin)
Laws of gravitation	....	10 Value of g to within $\frac{1}{2}$ %
Pendulums.........	Huygen's law	
Pneumatics	....	11 Take air pump apart 12 Plot curve of exhaust-ion-strokes 13 Smithsonian barometer temp. correct 14 Hights with aneroid 15 Density of dry air

3 Sound

Vibration	....	16 Fork to within $\frac{1}{4}$ %
Velocity............	....	17 Velocity in metal rods 18 Velocity in H and Co_2, Kundt tube
Doppler's principle..	Swing fork, high pitch	
The voice...........	Phonograph records developed	
Interference........	....	19 Measure wave of whistle (Raylight)

Outline of course (*continued*)

3 *Sound* (continued)

TOPICS	DEMONSTRATIONS	LABORATORY EXERCISES
Difference tones....	Two tin flutes	
Harmony and discord	Beats	
Combination vibs...	Vibrating string, lantern, mirror	20 Lissajous' figures
Transverse rods.....	....	21 Rod fixed on end, determine overtone
Chladni plates......	....	22 Six figures with conditions
Sensitive flames....	Tyndall's and Barry-Geyer	
Refraction..........	Bubble N_2O, flame, whistle	
Timbre.............	Helmholtz resonators	

4 *Light*

TOPICS	DEMONSTRATIONS	LABORATORY EXERCISES
Optical instruments	Stereoscope	23 Magnifying power of microscope or opera glass
	Spectacles (astigmatism)	
Lenses	Spherical aberration	
	Chromatic aberration....	24 Focal length of flint for different spectrum hues
	Achromatic lens	
	Achromatic prism	
	Direct vision prism	
Rainbow	Sphere of flint glass	
Concave mirror	Caustic curves	
The spectrum	Absorption spectrum—various	25 Line spectrum, metallic vapors
	Reversal of Na line.......	26 Identification of metals in mixture
Color mixture......	Van Nardroff's color apparatus	27 Plot Fraunhofer lines
Pigment mixtures..	Color mediums in lantern, spectrum	
Contrast	Lantern	
Interference of light	Colors of thin plates, various	28 Diffraction fringes slit, narrow obstacle, straight edge, disk
	Biprism (Fresnel's) and inclined screen	29 Wave length Na, grating
		30 Dia. lycopodium particles by diffraction pattern (Young) test with microscope micrometer
Polarized light	By reflection, transmission, double refraction, Nicol, tourmalin	31 Angle of polarization of water
	Strain glass..............	32 Record and explain colors of selenite, using spectroscope and various positions
	Heat glass	
	Unannealed glass	
	Starch in microscope	

Outline of course (*continued*)

4 Light (continued)

TOPICS	DEMONSTRATIONS	LABORATORY EXERCISES
Phosphorescence	Balmain's paint, warm	33 Phosphoroscope (Levison's) willemite, ruby and pectolite
Fluorescence	Magdala red, fluorescence. etc.	
Thermo luminescence	Chlorophane	
Ultraviolet light	Wood's screen Spectrum (quartz train) sulf. quinine, Ba Rt Cy etc.	
5 Heat		
Infra-red rays	Absorbers, radiators, reflectors, diathermancy	34 Compare radiators 35 Compare diathermancies
Radiometer	Radiometer, work both ways	
Mechanical equivalent		36 Joule's mech. equiv. to within 5%
Heat of combustion	O-H flame	
Expansion	Thermostats, Harrison's pendulum, balance wheel watch	37 Expansion mercury rel. to glass 38 Absolute exp. mercury
Regelation	Two blocks ice Ice and wire	
Hot air engine	Working model	
Gas engine	Working model, 4 cycle	
Temperature	....	39 Measure high and low temps. with Pl. res. therm.
Sat. and unsaturated vapors	Ether in barometer, warm water	40 Curve of vapor pressure of water from 50° C. to 100° C.
Heat by compression	Fire syringe	
Cold by expansion	Formation clouds	
Max. and min. therms.	Weather bureau patterns Clinical thermometer	
Annealing of glass	Prince Rupert's drop Bologna flask Paper weight or cheap glass in polariscope	
6 Electricity and magnetism		
Laws of mutual action of currents	Parallel, opposite and crossed currents Deflection of current by magnet	
Magnetism	Single loops sets E and W Solenoid sets N & S	41 Determine angle of dip by reversing needle and magnetism
	Magnetism induced by earth	42 Determine M × H
	Thermo-magnetic motor (nickel)	43 Determine M / H

Outline of course (*continued*)

6 *Electricity and magnetism* (continued)

TOPICS	DEMONSTRATIONS	LABORATORY EXERCISES
Static electricity...	Short duration of discharge Mechanical effect of discharge Heat effect of discharge Theory of condenser, illustrate Distinguish between potential and surface density	44 Arrange 5 substances in static-electric series
Thermo-electricity..	Simple junction, iron and copper Thermo-pile — galvanometer Thermo-battery—bell	45 Make thermo-electric diagram of two metals
Chemical effects....	Electrotyping............ Accumulator - : 2 lead plates in dil. H_2SO_4, bell	46 Faraday's law with H, Cu and Ag (Don't regulate current, but place 3 voltameters in series)
Heat effects........	Nernst lamp glower with and without ballast—use Bunsen Nernst lamp Cooper-Hewitt lamp Electric blasting fuse Thick and thin wires, const. C or V Electric gas lighter	47 Watts per candle power of lamp (incandescent) run at different voltages 48 Heat equivalent of electric Joule to within 2 %
Magnetic effects....	Magnetic cut-out Hotel annunciator Magnetic door latch Para-magnetic and dia-magnetic substances (electro magnet)	49 Hysteresis curve of iron 50 Horse power and total efficiency of motor with varying load
Electric measurements with *good* voltmeter and ammeter, allowing for resistance of instruments	....	51 E. M. F. and resistance of Daniel cell with ammeter and resistance box 52 E. M. F. and resistance of Daniel cell with voltmeter and resistance box 53 E. M. F. and resistance of Daniel cell with voltmeter and ammeter
Condensers.........	....	54 Capacity of condenser by comparison with standard—High res. bat.

Outline of course (*continued*)

6 *Electricity and magnetism* (continued)

TOPICS	DEMONSTRATIONS	LABORATORY EXERCISES
Self-induction......	Kick coil (cigar or gas lighter)	55 Sel-finduction of coil by comparison with standard (Wheatstone bridge, steady and interrupted currents)
Wireless telegraphy	Working model	56 Resistance of coherer, both stages
Electro-magnetic waves	Absorption, reflection, refraction, interference, polarization	
Electric discharge through gases	Stratification tube, showing Cathode layer, Crooke's dark space, negative glow, Faraday space and stratification of pos-column	
Cathode rays (electrons)	Heat focus tube Magnetic deflection Phosphoresence	
Roentgen rays......	Photographic action Phosphorescing action Discharging action (+ and —) Relative penetration Hardness meter (Ag, and Al steps)	
Arc light...........	Regulating d. c. lamp	
Radium ($5 specimen)	A, B & G rays by photo of magnetic deflection Self-luminescence of Ba Ra Cl_2 Phosphorescence of Ba Pt Cy screen and willemite Phosphorescence of Sidots zinc blende (Spinthariscope Photographic action Discharging action (+ and —) Relative penetration	

Laboratory experiments

1 *Estimation of tenths and hundredths of a division.* Using engine-divided scales, estimate millimeters in a few tenths of an inch, and then check by seeing how many millimeters in the same number of whole inches.

2 *Micrometer caliper.* Measure numbered corners of square of plate glass, employing an accurate caliper such as made by

Browne & Sharpe. Estimate to tenths of a division on the head, and correct for zero error.

3 *Spherometer, lens.* An excellent spherometer is made by the Société Genevoise. A standard flat glass plate is necessary. Plate glass may be selected by an optical method for this purpose. A lantern condenser lens makes a suitable object, but a flatter lens is better.

4 *Optical lever.* A description of this experiment in an improved form will appear in *School Science* or elsewhere.

5 *Weighing by Gauss's method, using swings.* With a set of weights corrected by the teacher, excellent results may be obtained with a low priced balance, though agate bearings are desirable. Find the weight in grams of a standard ounce weight.

6 *Surface tension of soap water by rectangle.* Very concordant results are obtained with a balance reading to 1 mg, and a very thin brass wire frame 10 cm broad. The soap water may be held in a crystallizing disk. It should be deep enough, say 3 cm, to allow the whole frame, say 2 cm tall, to be immersed. Weigh the frame with film attached, the lower portion of the frame being under the soap water. Then weigh with film broken. It will be sufficiently accurate to measure the breadth of the frame over all and multiply by 2. If a thick wire frame is used, the circumference must be taken into account. Calculate tension for each cm of film.

7 *Law of efflux of gases H and* Co_2. A suitable apparatus will be described in *School Science* or elsewhere.

8 *Law of transverse breaking strength.* Screw rectangularly arched retaining blocks to table. Break wooden strips about ½ inch thick and 10 inches long by pulling up with 40 lb spring balance. Test law of thickness, length and breath.

9 *Moment of inertia by use of rings.* A suitable apparatus will be described in *School Science* or elsewhere.

10 *Value of g to within ½%.* The best method is with the use of even a very crude Kater's pendulum, timing it by method of coincidences with a well regulated clock pendulum. Ten times the above accuracy may easily be reached with either an electric or optical device for recording coincidences. However, Professor Boys's experiment, in which a weighted smoked glass falls in front

of an accurately timed tuning-fork can yield good results. It has the advantage of avoiding any improved formulas.

11 *Take air pump apart and reassemble.* Any ordinary pump in good order will produce a half inch vacuum, as measured by an air-free gage, and will hold it with only a very slow leak.

12 *Plot curve of exhaustion.* Use receiver. Provide a branch tube between cylinder and plate, and connect with small heavy white rubber tubing to top of barometer tube. Plot curve with number of strokes (toward the last they may be taken in groups of 10) as abscissae, and with hight of mercury in barometer tube as ordinates. Above this curve plot a horizontal line corresponding to the reading of an ordinary good barometer.

13 *Smithsonian barometer.* Correct for temperature of mercury and scale. Make vernier readings.

14 *Hights with aneroid barometer.* The instrument must be of fine construction. Measure hight of laboratory window above ground and then test with tape.

15 *Density of dry air.* Use balance sensitive to 1 mg and a 5 liter dry flask. Exhaust partially with air pump provided with air-free guage. Disconnect from pump after temperature has become steady. Weigh. Allow air to return through drying tube and weigh again. Read barometer and thermometer. Calculate weight of liter of dry air reduced to oC and to 760 mm.

16 *Fork to within ½%.* Use a simple electric pendulum (platinum point sweeping across narrow mercury trough) to actuate an electric time marker made from a telegraph sounder. This marker should make its taps at one side of the fork record directly opposite the stylus of the fork. Receive the record either on a smoked brass drum or on a very long smoked plate glass strip running in finely made guides. With a good pendulum and with care about handling the fork so as not to change its temperature an accuracy 10 times the above may easily be attained. The fork when accurately rated may be used in Experiment 10.

17 *Velocity of sound in metal rods.* Use rods of aluminium, steel, and brass vibrated longitudinally with rosined cloth. Determine number of vibrations with sonometer string and rated fork. The length of the rod represents half a wave length. Calculate velocity.

18 *Velocity of sound in hydrogen or carbon dioxid.* Use Kundt's tube and cork dust or lycopodium. Pass the dried gases by suitable connections into the tube at the adjustable end. A very instructive and important experiment.

19 *Measure wave length of inaudible sound from a Galton whistle.* Use sensitive flame and get nodes and loops (after Rayleigh's method) by reflection of sound from vertical glass plate. Shift glass plate through 20 or 30 modes using meter rod as guide. The distance between two nodes is a half wave length. From the velocity of sound calculate the frequency of the whistle.

20 *Lissajous' figures.* Use any of the common methods. Two pendulums swinging at right angles to each other and arranged to leave a resultant trace on smoked glass give the finest results.

21 *Transverse vibration of rod fixed at one end.* Use a light steel rod, say 2 mm diameter and 30 cm long, clamped firmly in a very heavy vise. Determine frequency of fundamental and of four overtones by means of calibrated sonometer string. Also test half the length.

22 *Chladin plate.* A very flat brass plate, $\frac{1}{16}$ in. thick and 9 in. square, does well. If not perfectly flat a little judicious bending will improve it. The sand figures (sand must be well washed and the plate perfectly freed from grease) show up better if plate is stained black. Record 6 figures with conditions of clamping, damping and bowing. Use bass-bow, and have sharp edges of plate rubbed off with a fine file or emery cloth.

23 *Magnifying power of microscope.* For rough measurements view millimeter scale on stage with right eye looking through microscope and a millimeter scale 10 inches away directly with left eye. So control the eyes as to make the images overlap. Though very crude, this method may be carried out in a few moments. For better work use a simple camera lucida made of cover glass mounted at 45° in front of the eyepiece, the microscope being made horizontal. The eye is held above the cover glass and directed downwards. Ten inches below the eye is placed a millimeter scale. Modify the illumination of this scale so that it may be seen easily in superposition with the reflected image of the stage micrometer. Instead of a microscope an opera glass may be tested by the first method using as an object the iron bars of

a railing, the small glass panes of a window, or the bricks or stones in a wall.

24 *Chromatic aberration of a simple lens.* For the object use a bright distant light (arc, incandescent, or Nernst) and receive image on ground glass. To color the light place directly in front of the source several thicknesses of ruby glass for red, and a glass cell containing ammonio-sulfate of copper for violet. Find the focal length for each of these colors. Their difference divided by their average gives the longitudinal chromatic aberration.

25 *Line spectra of metallic vapors.* Use a spectroscope provided with a scale and plot the emission spectra of several metallic salts held in Bunsen flame.

26 *Identification of metals in a mixture of salts.* Limit the mixture to several of the salts studied in the previous experiment.

27 *Plot Fraunhofer lines.* Use a narrow slit and direct the sunlight into the spectroscope by means of a mirror. For observing the extreme lines it will be necessary to open the slit a little and cut off the flood of light either by several thicknesses of ruby glass or by a dense solution of ammonio-sulfate of copper.

28 *Diffraction fringes.* Suitable apparatus will be described in *School Science* or elsewhere.

29 *Wave length of sodium light with glass grating.* Excellent gratings on glass made by photographic reproduction are now procurable at low cost. Through the grating view an illuminated slit or lamp filament under which is placed a meter rod. Read off on the rod the position of the diffraction image and from the distance of this image from the grating calculate the wave length. The grating spacing must be accurately known.

30 *Diameter of lycopodium particles by means of diffraction figure.* Details will be given in *School Science* or elsewhere.

31 *Angle of polarization of water.* Details will appear in *School Science.*

32 *Phosphoroscope; determination of relative persistance of phosphorescence of several minerals by Levison's method.* Will be decribed in *School Science* or elsewhere.

33 *Compare radiators.* Use Leslie cubes, thermopile and cone, and calibrated low resistance galvanometer or milli-ammeter.

The thermo-pile must be shielded from draughts and allowed to cool off thoroughly between the determinations.

34 *Compare diathermancies.* Follow methods described by Tyndall, *Heat as a Mode of Motion.*

35 *Joules mechanical equivalent of heat to within 5%.* Simple apparatus capable of yielding this accuracy is now furnished by dealers abroad.

36 *Expansion of mercury relative to glass.* Use "weight thermometer." Easy to make from test tube.

37 *Absolute expansion of mercury.* Use method of Delong & Petit in simplified form.

38 *Measure high and low temperatures with platinum resistance thermometers.* Details will appear in *School Science* or elsewhere.

39 *Curve of vapor pressure of water from 50° C to 100° C.* Surround upper part of simple barometer with water jacket. Heat water in jacket by forcing in steam from below, controlling the flow of the steam by a three-way stopcock. A few drops of water may be introduced into the barometer from below by means of a dropping tube. The depression of the mercury may be read off by a scale fastened to the barometer inside the jacket. The water of the jacket must be agitated by a suitable stirrer and its temperature determined with a calibrated thermometer. In plotting use temperatures as abscissae and vapor pressures as ordinates.

40 *Determine angle of dip.* Use inclination compass and reverse the axis of the needle and also its polarity.

41 *Determine $M \times H$.* *See* Stewart & Gee.

42 *Determine M/H.* *See* Stewart & Gee.

43 *Arrange five substances in static electric series.* Details to appear in *School Science.*

44 *Make thermo-electric diagram of two metals.* Details to appear in *School Science.*

45 *Faraday's law, using H, Cu, and Ag.* Place the three volameters in series. It is not necessary to regulate or measure the current; simply try to show that the amounts of the elements separated are proportional to their "combining weights."

46 *Watts per candle of an incandescent lamp run at different voltages.* Use good voltmeter and ammeter, and any form of photometer. Modify the voltage across the lamp's terminals by placing resistance in series, such as a water rheostat. Plot a curve.

47 *Heat equivalent of electric Joule to within 2%.* For calorimeter use gallon tin pail with tin cover, and supported on three corks. Fasten binding posts to tin cover and support coil of high resistance ("Krupp" or "Climax") wire. Arrange a simple stirrer to keep weighed water in pail of uniform temperature. Pass a calibrated thermometer through tin cover. Use about 1000 watts, and measure with voltmeter and ammeter. Correct for specific heat of apparatus, stem error of thermometer, and for radiation.

48 *Hysteresis curve of iron.* Use simple magnetometer with compensation coil, good ammeter, and rheostat. Plot curve.

49 *Horse power and total efficiency of motor with varying speed.* Measure watts supplied. Measure speed. Measure torque with Prony brake. Calculate power. Plot curved.

50 *E. M. F. and resistance of Daniel cell with ammeter and resistance box.* Correct for resistance of ammeter.

51 *E. M. F. and resistance of Daniel cell with voltmeter and resistance box.* Correct for resistance of voltmeter.

52 *E. M. F. and resistance of Daniel cell with voltmeter and ammeter.* Correct for resistance of instruments.

53 *Capacity of condenser by method of comparison with a standard.* Use high resistance ballistic galvanometer.

54 *Self-induction of a coil by comparison with a standard.* Use method of Wheatstone bridge, employing steady and interrupted (induction coil) currents.

55 *Resistance of coherer, both stages.* Use "Postoffice" pattern of Wheatstone bridge. Nickel filings may be used in a glass tube having $\frac{1}{16}$ inch bore. Brass terminals, amalgamated at their ends, should be led in. Different pressures may be tried.

Naturally to any one planning to try this course the matter of expense will arise. It is intended that the experiments should be of a higher order and accuracy than those usually employed in first year physics, and so the average cost of a single experiment

will be greater. But on the other hand, since the pupil arrives at this second year's work with a general knowledge of physics, it is not so important to duplicate apparatus, though this may be done in a few easy cases in order to keep the class going. Most excellent ammeters and voltmeters may now be obtained from the Weston Electrical Instrument Co. for about $14; they only differ from the finest instruments in the appearance of the case, and in the accuracy of calibration. The internal mechanism is identical. Hans Heele, Berlin, furnishes an excellent spectroscope with the densest flint prism, telescope, and illuminate scale for $20. With a few good instruments of this sort as a basis, a teacher with some mechanical ability and $100 or so can work up a very worthy course. However, a few thousand dollars could scarcely be put to better use.

With one or two exceptions all the laboratory experiments mentioned in the list have been well tested by members of the committee, and are therefore presented with some degree of confidence. The same statement may be made with regard to the demonstrations.

Respectfully submitted

ERNEST R. VON NARDROFF, *Chairman*
Erasmus Hall High School, Brooklyn
R. J. KITTREDGE, Schenectady Union Classical Institute
A. L. AREY, Girls High School, Brooklyn
O. C. KENYON, Syracuse High School
C. N. COBB, Regents Office, Albany
Committee

O. C. Kenyon—The present syllabus in physics is certainly a great improvement over the preceding one. Let us first acknowledge and emphasize that fact. I think, moreover, that as science teachers, we should congratulate ourselves on having at Albany a body of men who are so able, and so willing to listen to, and to adopt, suggestions that seem to be in the line of progress. I doubt whether any other state is so well favored in this respect.

The relative amount of credit for laboratory work, the choice of certain questions in the examinations out of a number, the

character of the questions—in fact, everything connected with the Regents work has been to me satisfactory.

A pupil well prepared finds the examination easy as he should, while a careless or a poorly prepared pupil is likely to fail, either from selecting the wrong questions or else from answering thoughtlessly.

I am not in favor of a course in which there shall be little or no laboratory work. To favor such a course would seem to me like lowering our standard and taking a step backward.

I think, however, that the present course would be improved by arranging the laboratory and class work along parallel lines, by changing some of the easier, qualitative experiments from the laboratory list to that of the classroom, but specially by making the individual experiments the backbone of the work, as has just been suggested for the course in chemistry, the other subject-matter being chosen, first, to prepare the pupil for these experiments, and, second, to illustrate their practical bearing and applications in life, that part of the study which to a large number is the most interesting and profitable. Of course, there would be some subjects taught which are not suitable for individual experiments, such as the law of gravitation, but I would make these as few as possible.

If, also, a beginning could be made in correlating the subjects of physics and mathematics, by introducing into the latter study some of our purely mathematical work, a great advantage would result to both studies. Some of the laws of physics, specially those that need no elaborate or difficult experiments to make them understood—the laws, for example, of weight as related to distance, the lever, the downward pressure of liquids and of the atmosphere, the formulae for tenacity and specific gravity—could be used in algebra and geometry under the heads of the equation, ratio, proportion, and in problems. If, besides, the subject of variation, or how a change in one of two related quantities affects the other, could be taught, that, also, would help us much. Physics is such a difficult study to those who come to it poorly prepared that we are justified, I think, in asking this aid of mathematics, though, no doubt, the profit, as I said, would be mutual.

As another improvement, the time for the course in physics should be lengthened. At the first meeting of this association in 1896, I remember saying to Mr Arey, then of the Rochester High School, that physics ought to be a three term (a year and a half) study. Mr Arey agreed with me. I also said that for several years I had been making it such by leaving the major part of electricity till the third term, and teaching that as a separate study. This practice we have continued to the present time.

It would be better, as has been suggested by Mr Cobb, to include in the supplementary course some of the present first year work in other divisions than electricity, and to add enough additional material to make a full two years course.

In each of the divisions of physics there are many advanced or supplementary experiments and laws which, while well within the mental grasp of secondary pupils, are absorbingly interesting, as valuable for mental training, and much more helpful afterwards, than many of the other subjects taught in their place, and this is true whether the pupil is to go to college or not.

I wish to say right here, that I do not see why we should put in the background the argument of utility. We believe in it thoroughly; then why not use, and make the most of it?

The only way to teach physics properly in one year is by omitting many topics that a high school pupil should know. By teaching properly, I mean thoroughly. Every year I am more sure that what can not be taught thoroughly ought not to be attempted, at least not in science. Such teaching must result in giving pupils both vague ideas and a bad habit, that is, the habit of being satisfied with vague ideas.

Besides, the attempt to crowd many difficult topics into a too short time is likely to impart a distaste for the study, certainly a most undesirable result.

The addition of individual laboratory practice has added many important facts to the already large store of knowledge that our students have to acquire. First, the apparatus for this work is to quite an extent different from that of the classroom. It must be studied, described, and a drawing made of it. Some attention must be given, also, to the degree of accuracy of the instruments used and of the result obtained, to the proper number of

figures to be kept in computations, and certainly a good deal of thought to sources of error or how a more accurate result might have been obtained, to omit which is to leave the pupil's mind in doubt as to whether a law has been really proven, or the reverse. All of this work demands time.

Important discoveries, inventions, and improvements in machinery are made each year, but who is able to teach worthily, for example, the subject of x-rays, or wireless telegraphy, or the gas engine, or the steam-turbine, or the properties of alternating currents of electricity, or the properties of radium, all of which are everyday topics? Or, if these are taught, which of the older, but quite as important subjects, are omitted?

Again, in order to make physics an interesting, real, and vivid study (and it is vivid ideas that last longest and count most in teaching), there must be a large number of class experiments, and not only the simpler ones, but often more complex apparatus is required which must be studied, drawn (if the work is done thoroughly), recited on; and all this before the study of the underlying principle, which is the real object sought, can be entered on.

For the reasons that I have given, and others, it seems to me that it would be taking steps in advance if the State, recognizing the difficulty and the importance of physics, should introduce into the course in mathematics some of the simpler physical laws, should arrange class and laboratory work along parallel lines, with special emphasis on the latter, and should extend the physics course to two years. The trend of opinion of teachers of physics throughout the country seems to me to be in these directions.

Prof. William Hallock—In general, I am very much in favor of the plan proposed, and believe that it will result in very satisfactory work, if it is conscientiously carried out under qualified instructors and with proper equipment. These two latter factors I believe to be the most essential for the success of this character of work in high schools. Whereas it may be possible for poorly qualified teachers to lead the student through the few elementary experiments required in the first year course, it is absolutely necessary that the second year work should be in charge of a person thoroughly qualified to present, not only the actual material which is required in the course, but to have such a com-

mand of the subject as to be able to follow up collateral points that are liable to arise at any moment, and in the successful discussion of which the teacher finds his best opportunity of holding the interest of the students and demonstrating to them that he has a reserve of knowledge beyond the immediate requirements, which must result in gaining their respect, and which is not possible so long as they feel that the teacher is telling all that he knows. With the grade of teachers now available in many of the better secondary schools, such a course is entirely practicable; but on the other hand it is useless to attempt the giving of such a course unless the authorities are prepared to supply an equipment which really deserves the name, and will enable the teacher and pupil to do the experiments, and not simply talk about them. I believe that in this second year course the quantitative idea should prevail both in lecture work and in the laboratory. In the discussions and demonstrations a large number of numerical problems, illustrating the application of the formulae to all possible cases should be required of the student. It is remarkable how long students may be familiar with the formula and the principle and still be unable to work out problems from given data. In the laboratory the work should, in practically all cases, be quantitative, and require a higher degree of accuracy than that attained in the first year work. I see no objection to repeating many of the experiments already performed, with better apparatus, and requiring a higher degree of accuracy. In the same way in the discussions and demonstrations, many of the subjects may be reviewed, giving additional details and more accurate application of the principles. In fact, it seems to me that the student may make at least two, and preferably three, journeys through the whole subject, touching on each of the fundamental points, but in each successive journey developing more elaborate detail and more careful and quantitative examination of the principles. For example, whereas the first course may touch but lightly on the phenomenon of the refraction of light with simple experiments and applications, the second time this subject is taken up, it may include a more careful examination, more accurate methods of determination, such details as total reflection, polarization, dispersion, spectrum analysis, correction of lenses, etc., still in a comparatively incomplete way;

and the third time, these subjects would include such things as anomalous dispersion, interference, diffraction, the grating, the phenomena of polarized light, and double refraction. In short, all the experimental material preliminary to mathematical discussions in the subject.

I believe that the proposed syllabus is entirely right in making no preparation for any particular engineering course. It should be considered in a general way and form a general foundation. As to the subject-matter of the syllabus, I have no fault to find with it whatever. In general, the material is well chosen and appropriate to such a course. As above remarked, however, its success will depend on the ability of the teacher and the character of the equipment. I might suggest that I think certain experiments, like more accurate work with the balance, with corrections for the weights, and inequality of the arms, and the buoyant effect of the atmosphere, might well be introduced with advantage; also work on the pendulum, careful determinations of time of vibration by various methods, and the curve for varying lengths. Under heat, Newton's law of cooling, accurately carried out, is instructive on the subjects of radiation and absorption, and determinations of specific heat and latent heat are very desirable, and not very difficult. Under light, I would suggest that the first few subjects on the stereoscope, rainbow, contrast etc., be put in a little bit later after the discussion of lenses and prisms. I think some good determinations of index of refraction and photometry are very desirable. A very good and simple experiment is determining the index of refraction of glass by means of the angle of maximum polarization. Under electricity and magnetism, I think the determination of H and M is a very good experiment, requiring consistent and accurate observation, the use of the ballistic galvanometer, also the efficiency curve of a battery. I think, in this course, the elementary manipulations of soldering, glass-blowing, the manipulation of gold leaf, cocoon fiber, etc., might incidentally be introduced. But I am confidant that the course as outlined, in proper hands, with proper equipment, will result in giving to the student a good quantitative grasp of the subject, which is certainly worth the five periods a week of 40 minutes each which the subject certainly should have.

REPORT OF COMMITTEE ON LABORATORY COURSE IN PHYSIOLOGY

GESTED LIST OF LABORATORY EXERCISES IN PHYSIOLOGY TO BE PERFORMED BY EACH STUDENT

BY C. N. COBB, REGENTS OFFICE, ALBANY, CHAIRMAN

Exercise to show mineral matter in bones
" animal "
Study of different kinds of joints, using parts of a skeleton
Tests for acids and alkalis
" starch
" grape sugar
" nitrogenous substances
" fats and oils
" mineral substances
Exercise to show digestion of starch
" " nitrogenous substances
" " fat
" osmosis
Circulation of blood in frog's foot, tadpole's tail or gills of necturus seen with compound microscope
Microscopic study of human blood corpuscles; also frog blood corpuscles
Microscopic study of prepared mounts, as section of lung, bone etc.
Exercise to show presence of carbon dioxid in expired breath
Study of gross structure of muscle
Exercise to show the temperature of the body
" blind spot
These are found in most of the textbooks.

GESTED DEMONSTRATIONS IN PHYSIOLOGY AND HYGIENE TO BE PERFORMED BY THE TEACHER

BY C. N. COBB, REGENTS OFFICE, ALBANY

Action of the diaphragm and the lungs
To show that pepsin and acid are necessary for gastric digestion
To illustrate the action of the heart and how it pumps the blood in only one direction
Preparation and test of oxygen

5 Demonstration to show how to check the flow of blood from a vein or artery
6 Study of the circulation of air in a schoolroom as related to ventilation
7 Dissection of heart of sheep or beef
8 Dissection of sheep's eye
9 Dissection of sheep's brain
10 Dissection of other organs of animals

Wednesday morning

GENERAL SESSION

A METHOD OF MEASURING THE AMPLITUDE OF VIBRATION IN STATIONARY SOUND WAVES

BY BERGEN DAVIS, COLUMBIA UNIVERSITY, NEW YORK

[Abstract]

The first paper described and exhibited a new effect discovered by the speaker which may be applied to the accurate determination of the amplitude of vibration in stationary sound waves.

This effect is as follows: if a small hollow cylinder, which is closed at one end, be placed in a stationary sound wave, it will be subject to two forces, one of which tends to orient it so that the axis of the cylinder will be perpendicular to the direction of vibration, and another force which tends to drive the cylinder across the wave in the direction of the closed end.

The actual cylinders used for these experiments were the gelatin medicine capsules used by physicians.

A measuring instrument was constructed by mounting two of these cylinders on a paper arm, and suspending the same by a torsion wire in the sound wave. The stationary sound was that produced in a stopped organ pipe. The pipe was blown so as to produce the first overtone. A thin rubber diaphragm was placed across the pipe at the node next the mouth. The interior of the pipe from this node to the closed end, which included just one half wave length, was thus shielded from the disturbances of blowing. The only motion within the pipe was oscillatory motion of the air particles.

The force acting on the cylinders when placed in the sound wave was carefully measured. The force was zero at the nodes,

and very great at the middle of the loop. The force varied from the nodes to the loop in such a way that if a curve was plotted having square root of the forces as ordinates, and the distances along the pipe as abscissae, the curve obtained was a true sine curve.

The force acting on the end of the cylinders is proportional to the square of the amplitude of vibration.

The amplitude of vibration may be found by the application of Bernouilli's equation $\frac{dp}{\rho} = -\frac{1}{2} u^2$, where u is the instantaneous velocity, and ρ and p are the density and pressure of the vibrating gas respectively.

In one pipe which was used in a series of experiments, the amplitude was found to be 4.3 mm when blown at moderate pressures.

THE ELECTRODELESS DISCHARGE IN HIGH VACUA, AND THE MEAN FREE PATH OF AN ELECTRON

BY BERGEN DAVIS, COLUMBIA UNIVERSITY, NEW YORK

[Abstract]

This paper contained the results of the investigations by the speaker on the theory of the electrodeless discharge. A demonstration was also given showing the electrodeless discharge and also exhibiting the rotation of a miniature anemometer in the discharge.

The discharge was produced by a Leyden jar system. This system was constructed with four jars arranged two in series and two in parallel. The inner coatings were connected to the spark gap, and to the terminals of the secondary of a large induction coil. The outer coatings were connected to a coil composed of a few turns of coarse wire.

When the sparks passed at the spark gap, a brilliant white discharge was produced in a properly exhausted vessel placed in the small coil.

A vessel was shown containing a small glass anemometer. Where the discharge passed in the vessel, the anemometer rotated with a high velocity. This rotation is probably due to the impact of the moving electrons driven by the oscillating electromotive force.

An investigation of the starting potential of the discharge was described. The least potential (volts per cm) necessary to produce the discharge was measured at various pressures. The starting potential was found to decrease with decreasing pressures to a certain pressure, and then rise again to a great value.

The pressure at which the minimum occurred varied with the frequency of oscillation. The potential gradient at pressures below the minimum also depended on the frequency of oscillation of the Leyden jar system.

Curves of the starting potential at various pressures for the two frequencies were shown. From these curves the theory of the discharge was deduced.

This discharge consists of a current of electricity passing in a ring form around the vessel in the gas. This current is really a stream of free electrons moving with a great velocity through the gas. The impact of the electrons with the molecules causes them to emit light. The electrons come from the atoms of the gas. When the discharge ceases the electrons return again to the atoms from whence they came. The number of electrons present is very great, being more than 1,000,000,000 for each cubic centimeter.

The electrons are driven from the atoms by the impact of other electrons. There are a few free electrons always present. Suppose one of these to move through the gas. If it has sufficient energy it will drive another electron out of an atom. These two electrons move forward and produce two others, and so the ionization builds up to a high value.

Let N_0 be the original free electrons present. These build up by impact to N electrons in time T according to the following formula: $N = N_0 e\, x^{a}$, where N is the number of electrons present in the discharge, $x = \log_e \beta$, where β is the number produced by one impact of one electron. A is the number of successive impacts made by the N_0 electrons in the time T of a half oscillation. The following formula is thus obtained for the discharge at pressure below the minimum: $X = \lambda \left(\frac{2 a^2 m}{T^2 e} + V \right)$, where X is the starting potential, λ is the mean free path of an electron, $\frac{e}{m}$ is the ratio of the charge of an electron to its mass, and V is a constant.

Experiments were made in air, carbon dioxid and helium.
The following results were obtained:

	V	λ / λ^1	A	E
Air				
Co₂				
Helium				

E is the energy in ergs required to take an electron from an atom.

λ / λ^1 is the ratio of the mean free path of an electron to that of a molecule.

The experiments were carried out at the Cavendish Laboratory, Cambridge, England.

REPORT OF COMMITTEE ON ST LOUIS EDUCATIONAL EXHIBIT

BY HUBERT J. SCHMITZ, GENESEO NORMAL SCHOOL, CHAIRMAN

The council which was elected by the different societies of the State of New York to consider the educational exhibit at the St Louis Exposition advised the election of DeLancey M. Ellis as director of education.

Mr Ellis was subsequently appointed director by Mr Rogers, and he retained the original members of the council as an advisory committee. This committee met at different times and outlined the general plan of the educational exhibit which Director Ellis is now carrying out.

There were no funds available from this association and no special notices could be sent out. As the members of this association are nearly all members of some educational institution and all these were specially informed by circular letters from Director Ellis, no special notices were needed.

Mr Ellis desires, however, that this association cooperate with him in the gathering of a complete and interesting exhibit of homemade apparatus and it is hoped that the individual members can help to a great extent in making our exhibit the equal of any which *will be found at* St Louis.

MEMORIAL TO ROBERT HENRY THURSTON

BY PROF. SIMON HENRY GAGE, CORNELL UNIVERSITY, ITHACA

The science teachers of this State, and indeed of every state and country lost a warm friend and supporter through the death of Robert Henry Thurston, director of Sibley College, Cornell University. Dr Thurston was born Oct. 25, 1839, and died on his birthday in 1903. Death was quick and painless in the midst of full activity. He was spared the pain of failing mental and physical power which comes with slow dissolution.

His early life was passed in Providence R. I. and here he received the liberal education offered by Brown University. He served his country in the engineering corps of the navy during the stirring times of the Civil War. In 1865 he became a teacher in the naval academy at Annapolis. In 1871 he entered on his duties as professor of mechanical engineering at Stevens Institute, and there established the first laboratory of mechanical engineering in America. In 1885 he became director of Sibley College, and continued his work in that position to the day of his death.

His liberal university training, the practical knowledge gained in his father's engine shops, the duties of naval engineer in actual war, all conspired to make him appreciate the needs of his growing country. If it was to become great and powerful, the sciences, resting at the basis of all material progress must, he knew, be cultivated; guesswork must be replaced by mathematics, and rule of thumb give place to the experimental laboratory with its instruments of precision. That such a man would appreciate the science teachers is almost axiomatic. We have a very practical proof of his interest and friendship in the address he gave us at the Rochester meeting in 1900. His own work was mostly in the higher fields, but he realized that the science teachers of the secondary schools were giving the men of the future their initial start. It was always as a colleague, a fellow-teacher that he met us, and gave the hand of friendship and the word of encouragement. This friendship for the science teachers had a very practical bearing also, for his relations with men great in power and in means made it possible for him to impress on them the importance of our work. That our standing in the educational world is growing more and

more pleasant and highly esteemed is known to us all, and such men as Dr Thurston have been largely instrumental in bringing this about.

Of his own greatness the work of the Stevens Institute and of Sibley College, and his written books and addresses give abundant evidence. Frequently, however, as one contemplates the splendid achievements of a life something of regret mingles with one's thought. Fortunately no regret can come when his life is reviewed. He had great opportunities and he used them greatly, and for the benefit of his fellow-men. Here is a part of the tribute from his colleagues of the Cornell University faculty:

In all his relations to general university problems he exhibited the spirit of the scholar and the wisdom of a man of affairs. Serene in temper, sound in judgment, swift and certain in action, he justly exercised a weighty influence in all our counsels.

As a friend and companion he manifested a cordial sympathy that attracted all who knew him and held them in the bonds of an increasing affection.

In all the relations of life he moved upon the higher levels and showed forth the better qualities of our nature.

But after all nothing is so pleasant to remember of a dead friend as his own best words, for they represent his ideals and aspirations. In one of his addresses he thus characterizes a scientific man: "He is distinguished by a love of nature and all her works, a love of learning for its own sake, a love of scientific methods and scientific work in research as intrinsically attractive, as well as a means to an end. He is characterized, in the ideal type at least, by an absolute conscientiousness, infinite courage and invincible persistence, perfect faith in the complete accordance of all truth."

MEMBERS 1903

When the name of an institution includes the name of its town or city, the latter is not repeated. Where no state abbreviation is given, New York is to be understood.

Almy, Maud E., 16 Miegs st. Rochester, Cruttenden School
Alverson, B. W., Dexter
Arey, Albert L., Girls High School, Brooklyn
Arnold, J. L., DeWitt Clinton High School, New York
Atkinson, George F., Cornell University, dep't of botany, Ithaca
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Burchell, Durward E., Oswego Normal School
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Chollar, Sarah V., 91 Main st. Potsdam, Normal School
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Denham, Henry H., 146 N. Pearl st. Buffalo, Central High School
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Hale, Albert C., 352A Hancock st. Brooklyn, Boys High School
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Hallock, William, Columbia University, New York
Hancock, W. J., Erasmus Hall High School, Brooklyn
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Hargitt, Charles W., Syracuse University
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Henshaw, Hoyt, Stockton
Hering, D. W., New York University
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Hersey, C. Brooks, Masten Park High School, Buffalo
Hill, R. V., Jamestown
Hixon Kate B., 24 E. 128th st. New York
Holdredge, F. L., Hudson High School

Holly, Harold A., Warsaw High School
Hopkins, T. C., Syracuse University
Hudson, George H., Plattsburg Normal School
Humphrey, O. D., Jamaica (L. I.) Normal School
Hunt, Arthur E., Brooklyn Manual Training High School
Hurd, Frances, Oneonta Normal School
Jameson, J. M., Pratt Institute, Brooklyn
Jewett, Franklin N., Fredonia Normal School
Karpenski, L. C., Oswego Normal School
Karr, Grant, Oswego Normal School
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Keller, Christopher, Luzerne High School
Kelly, Henry A., 109 W. 54th st. New York, Ethical Culture School
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Kittredge, R. J., Erie Pa.
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Kraus, E. H., 907 E. Adams st. Syracuse, High school
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Langworthy, William F., Colgate Academy, Hamilton
Lee, Frederic S., 437 W. 59th st. New York, Columbia University
Lennon, Alice L., Brockport Normal School
Lennon, W. H., Brockport Normal School
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Lewis, Fred Z., Brooklyn Boys High School
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Logan, Mrs Mary C., Lyons High School
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Lovell, Thomas B., Niagara Falls High School
Lyon, Howard, Oneonta Normal School
McGreevy, Thomas, 200 Albany st. Buffalo, High Street School 39
McKay, John S., 460 Greene av. Brooklyn, Packer Collegiate Institute
McMurry, Frank M., Teachers College, New York
Mann, Warren, Potsdam Normal School
Mar, Frederick W., Brooklyn Boys High School
Marcella, Sister M., Nazareth Academy, Rochester
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Merrill, F. J. H., New York State Museum, Albany
Merritt, E. G., Lafayette High School, Buffalo
Meserve, Elizabeth E., Utica High School
Metzler, W. H., Syracuse University
Miller, Gertrude, Penn Yan Academy
Miller, Mrs Mary Rogers, Cornell University, bureau of nature study, Ithaca
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St John, Thomas M., 352 W. 56th st. New York, Browning School
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Schneider, Philip F., 319 Jackson st. Syracuse, High School
Schuyler, Erwin H., Erie (Pa.) High School
Scott, Charles B., Oswego Normal School
Scott, Irving D., 215 Erie st. Syracuse, High School
Scribner, E. E., Dunkirk High School
Seymour, A. T., 3080 3d av. New York
Shatz, Josephine, Rochester High School
Shear, S. R., Kingston

Shearer, John S., Cornell University, Ithaca
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Sieberg, W. H. J., Hotel Winthrop, 7th av. & 125th st. New York, School 43
Sleeper, Joseph J., Room 810, Provident Bldg., 4th & Chestnut st. Philadelphia, Pa.
Smallwood, W. M., Syracuse University
Smith, Oren R., Amsterdam High School
Smith, H. Monmouth, 701 University av. Syracuse, University
Stannard, J. Ellis, Oswego
Steurwald, Fred. Newark, Glens Falls High School
Stocker, John H., 124 Hancock st. Brooklyn, Boys High School
Stoel, T. B., Sacketts Harbor
Stoller, James H., Union College, Schenectady
Stone, Anna J., Binghamton School 13
Stowell, T. B., Potsdam Normal School
Tappan, Frances, Oneonta Normal School
Tarr, Ralph S., Cornell University, geological dep't, Ithaca
Taylor, Joseph S., 2275 Aqueduct av., University Heights, New York, Editor *Teachers Magazine*
Taylor, R. A., Niagara Falls Dep't of Education
Tenney, Lloyd S., University of Rochester
Thomas, M. Smith, Central High School, Buffalo
Trant, Amelia E., Masten Park High School, Buffalo
Turner, George M., Masten Park High School, Buffalo
Underwood, L. M., Columbia University, New York
Van Arsdale, May B., Teachers College, New York
von Nardroff, E. R., Erasmus Hall High School, Brooklyn
Ward, Charles H., 47 Mt Hope av. Rochester
Ward, Delancy W., 215 W. 42d st. New York
Warner, A. R., 36 Franklin st. Auburn
Watkins, Albert H., Richfield Springs High School
Weed, Henry T., 76 Court st. Brooklyn, Manual Training High School
Wetmore, Edward W., State Normal College, Albany
Wetmore, Katherine S., 84 S. Fitzhugh st. Rochester, High School
Wheelock, Charles F., Regents Office, Albany
Whitney, E. R., Binghamton High School
Wilber, T. C., Waterloo High School
Wilcox, C. C., Starkey Seminary, Eddytown
Wilder, Burt G., Cornell University, dep't of neurology, Ithaca
Williams, C. B., Chicago Laboratory Supply Co., Chicago Ill.
Williston, Arthur L., Pratt Institute, Brooklyn
Wilson, John D., Putnam School, Syracuse
Wilson, Victor T., Cornell University, Ithaca
Winchester, W. M.
Wixom, F. C., Penn Yan Academy
Wolcott, H. G., Clifton Springs
Woodhull, John F., Teachers College, New York
Wyckoff, Adelaide E., 58 Hanson place, Brooklyn, Packer Collegiate Institute

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Secondary Education

Bulletin 38

NEW YORK STATE SCIENCE TEACHERS ASSOCIATION

PROCEEDINGS OF THE

NINTH ANNUAL CONFERENCE

Held at Syracuse High School, December 27–29, 1904

ALBANY

NEW YORK STATE EDUCATION DEPARTMENT

1905

STATE OF NEW YORK

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Vice Chancellor - - - - - - - - - - Brooklyn
1908 DANIEL BEACH Ph.D. LL.D. - - - - - - - Watkins
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1912 T. GUILFORD SMITH M.A. C.E. LL.D - - - Buffalo
1905 ALBERT VANDER VEER M.D M.A Ph.D LL.D. - Albany
1907 WILLIAM NOTTINGHAM M.A. Ph.D. LL.D. - - Syracuse
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1911 EDWARD LAUTERBACH M.A - - - - - - New York
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New York State Education Department

Secondary Education

Bulletin 28

NEW YORK STATE SCIENCE TEACHERS ASSOCIATION

PROCEEDINGS OF THE

NINTH ANNUAL CONFERENCE

Held at Syracuse High School, Syracuse, December 27-29, 1904

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1908 L. V. Case, Washington Irving High School, Tarrytown
W. T. Morrey, Morris High School, New York city
J. S. Shearer, Cornell University, Ithaca
1907 A. W. Farnham, Oswego Normal School
O. D. Clark, G. W. Curtis High School, Staten Island
J. E. Kirkwood, Syracuse University
1906 G. M. Turner, Masten Park High School, Buffalo
E. N. Pattee, Syracuse University
A. G. Clement, Education Department, Albany
1905 Edward S. Babcock, Alfred University
H. J. Schmitz, Geneseo Normal School
William M. Bennett, Rochester High School

SUMMARY OF SESSIONS

Tuesday, December 27, 2.30 p. m.

Opening session; called to order by the retiring president, Irving P. Bishop, Buffalo Normal School

Introduction of President-elect Ernest R. von Nardroff, Erasmus Hall High School, Brooklyn

Science Study Parallel with Nature Study

William Hallock, Columbia University

The Use of Lantern Slides in the Teaching of Physiography (illustrated)

Ralph S. Tarr, Cornell University

SECTION MEETINGS

Tuesday, 4 p. m.

Section A—Physics and Chemistry. Henry H. Denham, Syracuse Business High School, *chairman*

Physics Teaching in Germany

F. L. Tufts, Columbia University

New Forms of a Thermo-phosphoroscope, a Photophosphoroscope, and a Tribo-phosphoroscope (illustrated)

Wallace G. Levison, Brooklyn

Experiments in Physical Chemistry for the High School (illustrated)

William J. Hancock, Erasmus Hall High School, Brooklyn

Section B—Biology. W. M. Smallwood, Syracuse University, *chairman*

A Round Table for the discussion of:

Field Work in Botany and Zoology

Edgar D. Congdon, Syracuse University

Section C—Earth Science. Amos W. Farnham, Oswego Normal School, *chairman*

Industrial Geography

Mrs Carrie L. Record, Fredonia Normal School

The Essence of Commercial Geography

Jacques W. Redway, Mt Vernon

An Apparatus for Showing the Direction of Sunrise and Sunset

Frank L. Bryant, Erasmus Hall High School, Brooklyn

Adaptability of Plant Geography as a Subject for High School Courses

W. W. Rowlee, Cornell University

Discussion of each paper under the five minute rule.

Section D—Mathematics. W. H. METZLER, Syracuse University, *chairman*

Geometry

W. H. METZLER, Syracuse University

Informal discussion.

Tuesday, 5.30 p. m.

Meeting of Council at headquarters.

Tuesday, 7.30 p. m.

Informal reception at the new high school in recognition of the 20th anniversary of the organization of the Associated Academic Principals.

Wednesday, December 28, 9 a. m.

Section A—Physics and Chemistry. HENRY H. DENHAM, Syracuse Business High School, *chairman*

Exhibit of Laboratory Experiments for Second Year Physics

Experiments in Radio-activity, Acoustics and Optics

L. V. CASE, Washington Irving High School, Tarrytown

Plotting Curve of a Vacuum Formed by an Air Pump

A. L. AREY, Girls High School, Brooklyn

Experiments in Vapor Pressure and the Value of *g*

R. J. KITTREDGE, Erie Pa.

Experimental Contributions from Erasmus Hall High School

E. R. VON NARDROFF, F. J. ARNOLD, F. W. HUNTINGTON, G. F. WILDER

A High School Class in Second Year Physics

O. C. KENYON, Syracuse High School

Experimental contributions from G. M. TURNER, Buffalo; C. H. HARRIS, Rochester; H. C. L. F. MORSE, Troy; and H. CATE, Boston

10.30 a. m. Reading of papers:

Are We Justified in Demanding a Second Year in Physics in the High School?

WILLIAM HALLOCK, Columbia University

A New and Simple Laboratory Apparatus for Accurately Rating a Tuning Fork's Vibrations (illustrated)

F. W. HUNTINGTON and E. R. VON NARDROFF, Erasmus Hall High School

Experimental Demonstration of Some of the Phenomena of Radio-activity

GEORGE B. PEGRAM, Columbia University

Wednesday, 9.30 a. m.

Section B—Biology. W. M. SMALLWOOD, Syracuse University, *chairman*

The Method and Scope of a Course in Biology for the First Year in the High School

CLARENCE W. HAHN, Commercial High School, New York city

The Formation of a New Species of the Evening Primrose; a Demonstration

J. E. KIRKWOOD, Department of Botany, Syracuse University

The Scope and Method of Scientific Nature Study

M. A. BIGELOW, Teachers College, Columbia University

Discussion

L. B. GARY, Buffalo Central High School

The making of Laboratory Notebooks and Kindred Topics

MINNIE L. OVERACKER, Syracuse High School

Wednesday, 9.30 a. m.

Section C—Earth Science. AMOS W. FARNHAM, Oswego Normal School, *chairman*

Laboratory Work in Physical Geography for Secondary Schools

CLARA B. KIRCHWEY, Teachers College, Columbia University

Physiography in the Morris High School, New York city

WILLIAM T. MORREY

a The Determination of a North and South Line, the Altitude of the Sun, and the Latitude of the Observer

b The Making of a Modified Mercator's Map of the World

W. W. CLENDENIN, Wadleigh High School, New York city

Some Contributions to Laboratory Physiography

WILLIAM F. LANGWORTHY, Colgate Academy, Hamilton

Relation of Geography to History

Sup't AVERY W. SKINNER, Oneida

Geography Materials at Hand

ANNA J. STONE, Jarvis Street School, Binghamton

Wednesday, 9.30 a. m.

Section D—Mathematics. W. H. METZLER, Syracuse University, *chairman*

Algebra

F. L. LAMSON, University of Rochester

Informal discussion

The Laboratory Method of Teaching Mathematics
W. BETZ, East High School, Rochester
The Teaching of Geometry
W. BETZ, East High School, Rochester
General discussion

GENERAL SESSIONS

Wednesday, 2 p. m.

On the Action of Ultraviolet Rays, Roentgen Rays, Radium Rays, and Other Influences on Mineral and Gem Substances (illustrated)
GEORGE F. KUNZ, New York city

Wednesday, 3.30 p. m.

Joint session with the Associated Academic Principals
In the Convention Room of the City Hall

The Preparation of Outlines in Science Subjects for the Regents Syllabus, 1905
Sup't DARWIN L. BARDWELL (A. A. P.)
The Preparation of Outlines in Physics and Chemistry for the Regents Syllabus, 1905
GEORGE M. TURNER, Masten Park High School, Buffalo (N. Y. S. S. T. A.)
Informal discussion
The Place and Function of Biology in Secondary Education
CHARLES W. HARGITT, Syracuse University (N. Y. S. S. T. A.)
Discussion
Prof. HOWARD LYON, Oneonta Normal School

Wednesday, 8 p. m.

Joint meeting, City Hall
Address, The New York Secondary School System
Hon. ANDREW S. DRAPER LL.D., Commissioner of Education

Thursday, December 29, 11 a. m.

At the High School, Physics lecture room
The Development of Old Theories in Molecular Physics from Corpuscles to Electrons (illustrated)
J. S. SHEARER, Cornell University
Report of Committee on Alcohol and Narcotics presented by
IRVING P. BISHOP, *chairman*

Report of Committee on a Syllabus for Second Year Physics in High Schools presented by

Prof. ERNEST R. VON NARDROFF, Erasmus Hall High School, Brooklyn, *chairman*

Report of Committee on Laboratory Course in Physiology presented by

CHARLES NEWELL COBB, State Education Department, *chairman*

Report of Committee of the State Science Teachers Association on the Syllabus Revision in Physics and Chemistry presented by

GEORGE M. TURNER, Masten Park High School, Buffalo

Adjourned

SUMMARY OF ACTION

Alcohol and narcotics. Prof. I. P. Bishop presented the final report of the committee on alcohol and narcotics as published in the proceedings of this association for 1903 [*see* p. 181].

Moved and carried, That the report be accepted and the committee discharged with the thanks of the association.

Physiology. C. N. Cobb presented the report of the committee on a laboratory course in physiology [*see* p. 182]. *Adopted* and the committee continued.

Physics. Pres. E. R. von Nardroff presented report of committee on syllabus for second year physics [*see* p. 182]. *Adopted* and the committee continued.

Physics and chemistry. Prof. G. M. Turner presented the report of the committee on the preparation of outlines in physics and chemistry for the Regents syllabus for 1905 [*see* p. 182].

Moved and carried, That the report be adopted and that copies be sent to the State Education Department.

1905 meeting. The council's report recommended that Syracuse be the next place of meeting unless the officers prefer to meet in New York. *Carried*

Federation. Prof. E. N. Pattee was appointed to meet with the committee to consider the question of the proposed federation of the several educational bodies.

Honorary member. Dr Franklin W. Barrows of Buffalo was elected an honorary member of this association.

Arrearage. *Moved and carried*, That all persons shall be dropped from the rolls who are two years in arrears for dues, but persons so dropped may be reinstated on payment of the back dues.

Nominations. The nominating committee made the following nominations:

President, Prof. A. P. Brigham, Colgate University, Hamilton

Vice president, Prof. G. M. Turner, Masten Park High School, Buffalo

Secretary and treasurer, Prof. J. E. Stannard, Owego High School

Members of council, 1908, Prof. L. V. Case, Washington Irving High School, Tarrytown; Prof. W. T. Morrey, Morris High School, New York; Prof. J. S. Shearer, Cornell University, Ithaca

Elected

Treasurer's report

Summary as per books and vouchers on file for year ending Dec. 29, 1904

Receipts

Dec. 30, 1903 Balance on hand	$2 23
Dec. 29, 1904 Dues to date	180 ..
	$182 23

Expenditures

Dec. 29, 1904 Total to date (as per items and vouchers on file)	$161 61
Balance on hand	20 62
	$182 23

Auditing committee. We have examined the accounts of the treasurer and find them correct.

E. N. PATTEE
G. M. TURNER
O. C. KENYON

Moved and carried, That the report be accepted.

ADDRESSES, PAPERS AND DISCUSSIONS

Tuesday afternoon, December 27

The Association was called to order by the retiring president, Irving P. Bishop, who said:

In terminating my duties as president of this association allow me to express my appreciation not only of the honor you have shown me, but also of the generous support you have given your presiding officer.

It has been a pleasure to feel your ready sympathy and prompt responsiveness, both of which have greatly facilitated the transaction of business. The memory of your courtesy is ample reward for the labor and care incident to the position.

I trust that I may be pardoned for alluding to the narcotics committee, the report of which is now completed and before you. The committee has been at work since 1898. The task has been much more onerous than was at first expected, and the report delayed far beyond the date originally anticipated. The committee has endeavored to present a dispassionate statement of facts bearing on the effects of alcohol and tobacco on the human body and believes its report affords a basis for the rational teaching of physiology which teachers will be prompt to utilize.

In the course of business connected with the preparation of last year's program, I became acquainted with a gentleman who impressed me profoundly not only as a scholar and teacher but as a business man. Whatever he had to do was done promptly, energetically and thoroughly. The association also recognized these qualities and has paid him the highest possible compliment in its power. I now have the great honor and pleasure of presenting your president for the ensuing year, Prof. Ernest R. von Nardroff of the Erasmus Hall High School, Brooklyn.

President-elect Ernest R. von Nardroff. *Ladies and gentlemen:* I fear it will be hard for me to justify some of the complimentary remarks of the retiring president. Already, I see that our Roentgen ray apparatus on which we depended for some of the demonstrations planned for this afternoon has failed us. However, such disappointments are naturally incidental to experimental work arranged for a place far distant from the home laboratory.

And here I wish to call attention to the unusually large number of papers on the program promising experimental illustrations. A teacher must grow in two ways. He must not only learn improved methods of presenting old materials, but he must become familiar with new discoveries, theories and apparatus. It is therefore with considerable gratification that I observe these large tables filled with apparatus and hear the bustling in the adjoining laboratories.

Unforseen circumstances make it imperative that Mr Kunz leave Syracuse tonight, and so we shall endeavor to find room at the present session for his paper arranged for tomorrow afternoon. Without further delay then, we will immediately pass on to the reading of the first paper on the program, "Science Study Parallel with Nature Study" by Prof. William Hallock of Columbia University.

SCIENCE STUDY PARALLEL WITH NATURE STUDY

BY WILLIAM HALLOCK, COLUMBIA UNIVERSITY

The fact that "things in motion sooner catch the eye than what not stirs" has been the chief argument in favor of an early study of animals in the elementary grades, and along with these, flowers have monopolized the time and attention of child and teacher.

To my mind the chief benefits of nature study are outdoor exercise, and the ability to see. If nature study is to be carried on in the classroom, with only infrequent excursions to field and wood, it becomes a laboratory exercise, and does not differ essentially from similar possible exercises in chemistry or physics or mechanics. A child is amused by an animal, largely because it moves, because it acts independently, it does things more or less unexpected. The curiosity is excited as to what it will do next, and in fact much of the study of animals, and much of the information taught concerning them deals with statements as to what the particular bug or beast will do under given conditions. For example, the special leaflet on the toad; considerable interest is worked up for this lowly and phlegmatic neighbor, but how much of the information can be the result of direct observation on the part of the child? One must be favorably situated, both as to time and place, to be able to observe even his fly-catching, which is his peculiarity most likely to interest the child and most readily seen. All the phenomena of spawn, tadpole, little toads, and related matters are practically unavailable in the majority of cases, except in the form of stories by the teacher. Of course it is useful to teach that even the humblest of nature's works is full of interest and worthy of the most careful examination. Let us for a moment compare this exercise with the same time spent with a couple of small magnets, a little compass and some iron filings. Here is all the interest of motion, and motion in things usually considered incapable of independent motion. The bristling of iron filings on a card over a little magnet is an entirely novel observation, and one calculated to excite the keenest interest. The picking up of tacks and small iron objects and the inactivity of brass, copper, silver etc. are readily shown, and may be nicely emphasized by the little song of the silver churn from *Patience*. Even the phenomena of magnetism induced in a piece of soft iron can be made perfectly intelligible to any child, and all of these experiments can be performed in any room at any time of year, and at less expense than the price of a toad. The magnetic tack hammer is sure to interest a child and the behavior of the compass

needle, including its north-indicating property, and how it serves to guide the mariner at sea, will serve as texts for stories galore. A small piece of lodestone will help to make real the discovery of this property, and floated on a piece of cork or wood will illustrate the guide which helped the first great discoverers to circumnavigate the globe. Have we not here as much evidence of the importance of the humblest observations, when a little piece of brown stone floating on a piece of wood in a vessel of water can direct a Columbus to a new world?

Leaves and twigs and plants are the subject of much deserved attention, and are studied in minutest detail. This is of course all very well when such materials can be obtained. Why not devote some attention to the phenomena of crystallization? The quick evaporation of many simple solutions when spread on glass furnishes figures quite as varied, quite as intrinsically beautiful, quite as instructive as any leaf forms, and quite as distinctive and much more positive and accurate. Even the added interest of color need not be lacking. Those charming little "hopper" crystals formed by the cubic crystallization of a solution of common salt, will interest the child and may be made to point a moral, or adorn a tale. The coordination of these phenomena with the ice figures on the window, and the beautiful crystals of the snow, will serve to occupy to advantage several winter periods. The sources of crystallization are almost endless. The beautiful colors of the rarest flowers can be more than matched for a few cents in the simplest of chemical experiments and is the one less wonderful than the other? Is the hand of Nature less apparent in the delicate crystal of most beautiful color and form, constructed with the accuracy of the mathematician, than in the petal of the flower?

Such parallels could be multiplied almost indefinitely, *sed ex uno disce omnes.*

There is one feature of nature study on plants and animals which has often been criticized by the ultrasensitive. I refer of course to the dissection, or destruction of the object of study. It will be answered that this is seldom practised with even the lowest forms of animals, and plants do not feel, and hence there is no objection to pulling them to pieces. Still the child must be held in constant check to keep down the natural instinct to see what the insides are like, to see what makes "the wheels go round." Perhaps it offers a good opportunity to teach the child not to inflict pain by pulling animals to pieces, but even so it is pretty difficult to differentiate between his curiosity to see how a fly will walk with only two legs,

and the scientific dissection for legitimate purposes. In general the child is naturally enough inclined to pull things to pieces without any encouragement. On the other hand the most sensitive can not object to an indefinite amount of pestering of a magnet, or a solution. The above matters are simply those of choice, perhaps, and someone may object that we have at best proved an equal claim for attention. There is however a more serious criticism of the present methods. In the syllabus we find for example a subject given as "the function of the roots." How can this subject be efficiently or rationally treated when the child has little or no knowledge of the simple and fundamental phenomena of solution much less of capillarity, or surface tension, or osmosis? It is again expected that the functions of the leaf should be intelligently discussed, without a preliminary knowledge of anything about evaporation or combustion, or the subtler effects of sunlight such as bleaching, discoloration, and chemical change in general. At another time the sap is the subject of the talk and the child is told how and why the sap rises in the tree, when in point of fact nobody knows. Right here is an example of a serious mistake which many teachers make; namely of picking out the plausible or attractive theory of all those which have been suggested to explain some phenomenon, and presenting this to the child as if it were finally established. This, to my mind, is positively bad, and is certainly unnecessary. I have always found that a child is really interested to find something which even the "grown-ups" do not know, they feel encouraged and may even set their little brains at work getting up an explanation of the observation in question. A teacher's usefulness has been seriously impaired the moment he or she poses before the children as knowing it all.

It will be objected that chemistry and physics require apparatus and materials and these cost money. I would guarantee to buy all the needed materials with half the money spent in a single year on nature study, and most of these materials would last several years at least. When I see the poor grade teacher coming home Saturday with her arms full of branches and twigs, in fact most any old thing, as a result of a forced trip to a roadside just outside the city limits, I always think what a fine physical experiment could have been arranged with half the time and trouble, and at a cost not exceeding her car fare.

The one real obstacle to the immediate introduction of this class of work into its proper place in the curriculum is of course, and as usual, the teacher. It will be objected that here is another subject

for her to study, another demand on her already overloaded time and energy, and she can not be expected to know enough chemistry and physics to teach these things properly. These same objections were urged with equal application against the introduction of the present form of nature study. For the surmounting of these obstacles I would make two suggestions. First, that the teachers in the grades should obtain constant assistance and direction, and instruction from the specialist teachers in the high school, or from supervisors, as at present in music, art work, etc. The high school instructor in chemistry and physics should always be available to show the grade teacher how to perform and explain these elementary exercises. Any good high school teacher would be glad to do this, realizing that thus would the work be done properly and an early foundation be laid on which later work in those sciences could the better be built up. Second, there should be prepared a set of leaflets containing complete and explicit descriptions of the exercises, directions for their performance, the materials needed, as well as a statement of the points to be specially emphasized and the conclusions to be drawn. Such a leaflet would enable any intelligent teacher to carry through the exercises on the magnets quite as satisfactorily as she could the corresponding one on the toad.

I would not for the world use one period for indoor laboratory exercises which could be devoted to a trip to real fields and real woods, to nature's real laboratory. Only do not let us try to get lively interest out of a lot of old dead leaves and sticks, or fool ourselves and cheat the children by roaming over some vacant city block, or through some very artificial park. When animate nature sleeps let us turn with equal zeal and interest to so called "inanimate" nature. Nature is in fact always animate. Let us turn to this phase of nature in the firm assurance that her treasures there are no less simple, no less fascinating, no less profitable alike to teacher and pupil.

THE USE OF LANTERN SLIDES IN THE TEACHING OF PHYSIOGRAPHY

BY RALPH S. TARR, CORNELL UNIVERSITY

For its adequate and scientific presentation physical geography presents difficulties which few other sciences possess. The botanist, zoologist, or mineralogist may bring his specimens into the lecture room or laboratory; the physicist or chemist may set up his apparatus and exhibit the actual phenomena; but the physical geographer

can not do this as he deals with objects and phenomena most of which can not come into the classroom. A beach, a delta, a glacier, or a volcano can not be kept in the laboratory storeroom.

It is this fact more than any other that has so retarded the development of scientific physical geography in the schools. Other sciences have developed systematic laboratory work, but, excepting in the universities and some of the better schools, the progress of physical geography toward scientific method has on the whole been slight.

There are five ways, aside from lectures and recitations, of partly overcoming the difficulty just mentioned—by excursions, by the use of models, by laboratory experiment, by maps and by pictures. The excursion, the best of all, takes the student to the actual process or phenomenon; but time, distance, expense and weather prevent the full use of this means of study.

By laboratory experiment many processes and results about which the class studies may be repeated in miniature. Such work makes heavy demands on the teacher's time and taxes his ingenuity; but its results are worth the expenditure of time and energy.

Models, representing actual or ideal land forms are excellent substitutes for the real thing; but, besides being small and generalized, they are expensive and, up to the present time, are few in number and cover only a limited range of phenomena.

Topographic maps, once understood, are nearly equal in value to models, and far less expensive. Moreover they include a much wider variety of land forms.

Pictures represent limited areas clearly, and they are both cheap and even at present fairly easy to obtain in great variety. If properly selected and properly used they constitute a valuable aid to the teaching of physical geography.

In my own instruction I make use of all five methods, and find each useful in its proper place and time; but each year I am making more and more use of pictures. It has become evident to me that a good picture is a much better substitute for an actual land form than any other that can be brought into the laboratory or lecture room. No matter by what device, whether by vivid description, by map, model, or experiment, in no way short of an actual excursion can so clear an idea be gained of, let us say, a glacier or a volcano, as by a picture.

Convinced of the correctness of this conclusion, I began some 10 years ago, the systematic collection of photographs illustrating physical geography. I now have about 5000 slides, a full third of

which I myself have taken in various parts of North America and Europe, with the special object in view of their application to my own instruction. There are probably 10,000 copies of such of these as my photographer duplicates now in use in the schools of the country.

A lantern slide is far preferable to prints because by that means an enlarged picture can be placed where each member of the class sees it. The first principle in the use of the lantern in physical geography instruction is to avoid employing it for a mere lantern show. I am informed that it is a common custom to set aside an occasional period for a lantern exhibit during which pictures are thrown on the screen to illustrate subjects covered since the last lantern exhibit. Almost the entire value of the use of the lantern must be lost by such a method.

To get the best good from the use of the lantern, not a picture should be admitted for mere show purposes, and no more should be employed than are absolutely necessary and at no other time than when they are really needed by the class. Each picture should become a necessary part of the exercise, and it should pay for itself by instructions given, and not merely by interest aroused, though if it interests as well as instructs, so much the better.

To insure the best results, I prefer to run my own lantern, having the screen on one side of the desk and the lantern on the other. The screen faces the class diagonally, and may be seen from all parts of the room excepting one corner. Running one's own lantern permits the introduction of a slide at the proper moment, and its reappearance if needed. It detracts somewhat from the smoothness of the lecture, and is somewhat distracting if the lantern behaves badly, as it sometimes will; but what is lost in this respect is amply made up in other ways.

The lantern may be used in the recitation, the review quiz, the laboratory exercise and the lecture.

In the recitations and review quiz, by the aid of a well selected series of slides the subject of the lesson can be kept before the class, and questions be asked somewhat as in a field excursion. In some respects the use of pictures is even more valuable than work in the field, for by them both time and distance may, in a measure, be eliminated.

These points were illustrated by a series of 20 slides. Two of these showed views of the same place at different seasons, thus eliminating time in a way that could not be done in field work except

by making two excursions to the same place. In the first view, taken in the fall, a cliff was shown with joint planes cutting across it; the second view, taken in the winter, showed huge ice columns extending from the joint plane to the base of the cliff. It was pointed out that by questions on the first view the class could be prepared for the condition illustrated in the second view, and that by a class study of the two pictures a valuable lesson in weathering could be taught, making use of the observational methods as in field work.

Two pictures of Taughannock falls in New York were then shown to illustrate the retreat of the fall in the interval between the time of taking of the two pictures, a retreat which had profoundly altered the shape of the crest of the fall. Here time was also eliminated, and only by the most fortunate choice of time for excursions could this kind of change be shown a class in field work, while the pictures made it possible to study the change in any class and at any time.

A series of four pictures illustrating the elimination of distance were then shown. These were pictures of talus deposits from various parts of the world, one from Cayuga lake, New York, one from the Rocky mountains, and two from Switzerland. These views were selected to show both the origin of talus and stages in the development of talus slopes. It was pointed out that by proper questioning a class could, from these views, be led to see how talus was caused and the characteristics of talus, almost as well as in a field excursion, and with the further advantage of comparison of conditions in various regions.

The next series of five slides illustrated the elimination of both time and distance. For this purpose a view was first exhibited of the flood plain of a western river, in which the inclosing bluffs, the level plain, and the abandoned channels were clearly shown. This was followed by four views of a small brook in New England in four different stages of flood from the low water to the high water stage when the entire flood plain was covered. Having first studied the characteristics of a flood plain, the process of the formation of such a plain was then revealed to the entire class. This could be done in a classroom in a short time, while in field work it would require at best several separate excursions to see the same phenomenon as clearly.

The remaining slides were used to illustrate how, by questioning, a pupil could be made to see phenomena and understand them from a clear and well selected slide, and it was urged that the use of

slides in recitations and review quizzes would greatly increase the value of the results in physical geography teaching.

Some of the methods of the recitation can be employed in the laboratory, and in some instances it is desirable to do so. There are, however, two directions in which the use of pictures seems specially adapted to laboratory work. The first of these is to supplement the field work by a laboratory study of pictures of phenomena near the school; for example, extending the study to regions difficult of access with the entire class or to a comparison of phenomena at different seasons from that in which the excursions were made.

A second direction in which slides are useful in laboratory work is in connection with the studies of maps or models.

This point was illustrated by eight sets numbering in all 30 slides. The first set included two slides of the plain of the Red river valley of the north, one a photograph of the Fargo sheet of the United States Geological Survey topographic sheets, the other a picture of the plain itself. The point of this comparison of map and picture was that, while a study of the map showed general levelness over the entire area, a study of the picture added something which the map could not show, namely a farm with its house and wide extending field of wheat.

With three slides of the Florida plain essentially the same point was made, but in this case, in addition to a slide showing the topographic map, there were two photographs, one showing the dry plain with scattered trees, the other the swampy prairie portion of the plain.

The third series made use of the Ithaca N. Y. sheet of the United States Geological Survey topographic maps, a dissected plateau region of rugged topography. After exhibiting a slide of the topographic map itself, a view was introduced showing the nature of this plateau topography, thus making vivid the main topographic lesson of the map. A second view looked down the main valley in which Cayuga lake is situated, and a third view showed one of the gorges which are cut in the sides of this valley. No amount of study of the topographic map could make clear the actual conditions on the Ithaca sheet to a person with the limited knowledge of topography possessed by the average high school pupil. Even a professional

physiographer could not infer from the map alone the characteristics of the gorges which cut the slopes of the Cayuga valley.

While a study of the map alone is unsatisfactory, so would the study of pictures alone be unsatisfactory. It is by the proper combination of the two methods that the best results are gained, the map showing the general relations over a wide area, the picture exhibiting portions of the area in detail and as the human eye sees it. With the aid of such pictures the lessons of the map become more real and vivid and consequently of a higher educational value.

Other series were shown in further illustration, one set of three exhibiting a map and two views of a drumlin region; another set illustrating Crater lake by two pictures, a slide of the Crater lake sheet, and a slide of the Crater lake model; and a third set illustrating by map, model and picture certain conditions in the Appalachians. In all three series the object was to show that the photographs served the double purpose of bringing the actual conditions before the student, and of exhibiting features which the map alone could not show.

A slide of the model of the state of Washington together with five photographs of various parts of the state, and a slide of the Colorado canyon model with four photographs, illustrated the same points merely substituting a model in place of a map as the base.

The use of the lantern in lectures is so generally recognized that little need be said about it. Let me repeat my conviction, however, that the method of having an occasional illustrated lecture, or postponing the illustrations to the end of the lecture, is decidedly inferior in value to that of using the illustration at the point in the lecture which it is needed to illustrate. No amount of description, however vivid, can equal a clear picture shown at the proper moment during the lecture. There is the danger of overillustrating, but a little experience teaches how to avoid this.

I am convinced that one of the greatest needs in physical geography instruction is the introduction of the use of lantern slides for the purposes outlined in this paper. Unfortunately it is true that the difficulty of obtaining proper illustrations for a complete course is now great, but the supply will come with the demand. Already one firm offers for sale slides for use in teaching physical geography, but there is need of other and better selected series, and

it would be an educational work of importance for someone to select such a series and make it generally available. It might not be financially profitable at first, but it would, I believe, pay well in the end.

Dr George F. Kunz delivered a paper on the action of radium, ultraviolet light, Roentgen rays, and the electrical action on precious stones and minerals; giving experiments with these agencies showing the fluorescence of fluorite, hyalite and other minerals, and the phosphorescence of selenite, kunzite, willemite, colemanite, and other minerals. The paper was illustrated with apparatus and specimens.

Tuesday afternoon

SECTION MEETINGS

Section A. PHYSICS AND CHEMISTRY

PHYSICS TEACHING IN GERMANY

BY F. L. TUFTS, COLUMBIA UNIVERSITY

[Abstract]

The paper on "The Teaching of Physics in Germany," by F. L. Tufts, gave the results of some observations the author had made in Germany during the winter of 1903-4 on the teaching of laboratory physics in schools below the grade of the universities and technical schools.

After giving a brief account of the German school system, it was pointed out that in the instruction covering the same school period as that covered by the American secondary school and the first two years of the American college, practically nothing in the way of laboratory instruction in physics is given in Germany. While physics is taught in all of the schools of this grade, the instruction is given by textbook, recitation, and lectures, usually illustrated by some lecture table experiments. Even in the "Real Gymnasium" and "Real Schule," where the classics have been to some extent replaced by the sciences and modern languages, practically no laboratory courses in physics are offered.

Among the very few exceptions to the above rule may be mentioned one gymnasium in Berlin where laboratory instruction in physics was introduced by Professor Schwabe. The experiments selected and the apparatus used are essentially the same as given in

the *Harvard Forty Experiments*. Professor Noack, in a gymnasium in Griessen, has also developed a course of laboratory instruction in physics which is usually elected by a large number of the class. In the very few gymnasia, however, offering laboratory physics the course is an optional one and in some cases must be given outside the regular hours.

It may be stated, therefore, that in the general scheme of education preceding the university courses no place is given in Germany to laboratory instruction in physics; and with not over a half dozen exceptions, no laboratory instruction is offered in any of the schools below the grade of the universities and technical schools.

NEW FORMS OF A PHOTOPHOSPHOROSCOPE A THERMO-PHOSPHOROSCOPE AND TRIBO-PHOSPHOROSCOPE

BY WALLACE GOOLD LEVISON, BROOKLYN

The photophosphoroscope consists of a cylinder of pasteboard or other light material provided with a bottom of wood and a metal taper socket by means of which it may be attached vertically at pleasure on the tapered axle of a small electromotor which is fixed to a board, that serves also as a screen in front of a lantern at such a distance that the cone of light from the condenser comes to a focus in the axis of the cylinder through a hole in the screen and a corresponding hole in one side of the cylinder. The cylinder is provided with a cover like a common round box cover in the center of which is a perforated metal fixture provided with a set screw whereby a wire with a clamp at the end may be so adjusted that an object held in the clamp will be in the axis of the cylinder exactly opposite the hole in its side. This object is subjected to the focus of the beam of light when the hole in the cylinder is on the side toward the lantern and is then invisible to an observer in front, but it may be seen in total darkness from all sides in front as the aperture revolves with the cylinder. Objects such as minerals thus revolve with the cylinder and the same side that is illuminated one moment is visible to the observer a moment later. The speed of revolution may be much greater than has been usually attained with the mechanical devices formerly employed and owing to the persistence of vision at all speeds greater than about 12 revolutions a second the object becomes visible with a characteristic colored light, if it affords a

fluorescent afterglow, just as if it were at rest. A like effect may be obtained by gluing a piece of the material on the outside of the cylinder.

In either of these ways a specimen of ruby or ruby corundum appears of a gorgeous crimson color; calcite from red to orange; hexagonite a fine orange; pectolite a brilliant yellow; willemite, autunite, salts of uranium, uranium glass and hyalite a fine green and calcozincite a fine blue. Other minerals afford similar or different tints but those which appear blue are rare.

Powder may be dusted on pieces of black paper coated with glue or varnish and papers then prepared may be folded around the cylinder and retained with rubber bands being thus interchangeable at pleasure. Material otherwise useless may be thus made available. Very little is required as only a narrow strip is necessary. The above mentioned minerals or materials thus examined afford in the dark brilliant bands of characteristic colors.

There is still another way of examining objects with the instrument, namely by transmitted light. For this purpose the cover of the cylinder is dispensed with and the specimen is held within the cylinder in a spring forceps which depends from a support fixed on the screen which supports the electromotor.

It is therefore held immovable and the cylinder revolves around it. Thus transparent objects may be examined, the observer seeing the side opposite to that on which the light is incident. This method discloses the surprising circumstance that thick specimens of some apparently opaque materials are thus excited to glow throughout, and is sometimes desirable for the examination of transparent gems.

By interposing screens of various colors between the condenser and the revolving cylinder the light acting on the material under examination may be limited to separate colors. Thereby it is found that with ultraviolet, violet, and blue light and all colors above that given by the substance under examination the phenomena are the same as with white light and that fluorescence is a step down transformation of wave energy and that therefore with red and infrared rays no effect is produced.

If however a screen be used such as Tyndall's which completely cuts off all visible and ultraviolet rays but allows the infrared rays to focus on the cylinder where they produce heat, substances such as boracic acid, fluorite, etc., which are thermo-phosphorescent may become luminous and produce bands of light and the instrument becomes a thermo-phosphoroscope, the second instrument

mentioned, thus showing that phosphorescence is a step up transformation of wave energy.

The third apparatus described, the tribo-phosphoroscope, shows the production of phosphorescent light by friction and the duration, intensity and spectrum of the light produced.

It has long been known that certain minerals as zinc blende or sphalerite, certain limestones (so called hell fire rock), etc., produce light when gently scratched or rubbed. This instrument is designed to elicit the light in its full intensity and maintain it steadily for examination. It consists of a disk of pasteboard coated with the material to be examined and revolved by any convenient device of sufficient power such as a recomposition of light apparatus. Against the sanded surface of the disk is held by a spring or otherwise a piece of the same material or a wire brush, a wooden splinter or even the finger nail, and a trail of light is produced from the point of contact extending more or less around the disk. The intensity of the light and its spectrum may be determined by the photometer and spectroscope applied near its source. Its duration is determined from the length of the trail produced on the disk at a known speed.

As the coating on such a disk is soon stripped off, it has been found desirable to replace the disk with a common grindstone. A piece of any material pressed against such a grindstone supplies a fresh coating continually and the luminous effects observed are fully as effective as with a sanded disk.

EXPERIMENTS IN PHYSICAL CHEMISTRY FOR THE HIGH SCHOOL

BY WILLIAM J. HANCOCK, ERASMUS HALL HIGH SCHOOL, BROOKLYN

During the past 10 years the electrolytic dissociation hypothesis has come to occupy an important place in the teaching of general Chemistry. The electrolytic dissociation hypothesis has been mentioned in all of the more prominent textbooks on elementary chemistry published within the last five years, but the subject has not been treated experimentally. I became tired of presenting the subject to pupils without giving demonstrations of a practical nature that would assist them in grasping the more simple conceptions of the hypothesis.

The following is a brief description of some of the experiments I have found to give satisfactory results.

Experiment 1

The object of this experiment is to show that certain aqueous solutions do not conduct the electric current while others do, or, in other words, since the electric current is transmitted through a solution by means of ions, to show that water does not ionize certain substances and does ionize other substances.

Two small copper plates were separated by a sheet of hard rubber $\frac{1}{16}$ inch thick and slightly larger than the copper plates. The copper and rubber were held together by small rubber bands. A short piece of copper wire was soldered to each of the copper plates and the plates connected in series with an incandescent lamp. On dipping the plates into a water solution of sugar and attempting to pass a 110 volt current through the system a negative result is obtained. The copper terminals when dipped into a solution of potassium hydroxid under the above conditions allow sufficient current to pass to cause the filament of the lamp to glow brightly. Obviously the experiment could be repeated with as many solutions as desired and the conclusion reached that water solutions of acids, bases and salts conduct the current or are ionized, while solutions of such substances as sugar, alcohol, glycerin etc. are not ionized.

Experiment 2

The object is to show that the molecular conductivity and consequently the ionization of an electrolyte increases with dilution.

A trough 19 inches high, 6 inches wide and 1 inch thick (inside measurements) was constructed in the following manner. The narrow sides of the trough were made of wood saturated with a cement made by melting together equal parts by weight of Venice turpentine and shellac. Strips of silver about $\frac{1}{100}$ inch thick and of uniform width were stuck to the inside of the wood by the cement mentioned above. The other two sides of the trough were formed of crystal plate glass cemented to the strips of wood, the arrangement being such that the silver strips form electrodes of equal width and parallel to each other. The sides of the trough thus made were cemented to a wooden base built up around them so as to leave a small space between the inside of the base and the sides of the trough. Binding posts were then screwed to the upper end of the electrodes.

The cell was connected in series with a lantern galvanometer, made less sensitive by placing a bar magnet under the needle, and a Daniell cell.

Water, recently distilled, is poured into the trough till it is nearly filled and no current is made manifest by the absence of any deflection of the shadow of the galvanometer needle on the screen. The distilled water is then siphoned from the trough and 20 cubic centimeters of a fourfold normal solution of silver nitrate substituted. A marked deflection of the needle is noted. About 100 cubic centimeters of distilled water is then added to the contents of the trough and an increase in the conductivity is made manifest. Sufficient water to fill the trough nearly half full is added and the increase in the deflection of the needle noted. Lastly the cell is nearly filled by the addition of distilled water and only a slight increase in the conductivity over that noted when the trough was half full is seen.

We thus observe that the first portion of water added greatly increases the conductivity and consequently the dissociation, while the last portion of water, though many times the first portion added, has little effect on the conductivity. Therefore, a large percentage of the molecules of silver nitrate must have been dissociated before the addition of the last portion of water.

Experiment 3

This experiment is to show that while water solutions of different acids vary greatly in conductivity or are dissociated to different degrees by water, their potassium salts are dissociated to about the same extent.

Four glass tubes about 8 inches long and 1⅛ inches in diameter were supported in a vertical position in a row. The lower end of each tube was closed by a single hole rubber stopper to which was cemented (same cement as mentioned above) a circular platinum electrode 1 inch in diameter. A copper wire soldered to the underside of the platinum disk passed through the hole in the rubber stopper. The upper end of each tube was closed by a single hole rubber stopper through which passed a glass tube to one end of which was cemented a platinum electrode of the same dimensions as the one mentioned above. A copper wire soldered to the electrode passed through the glass tube which was of the same length as the large tube carrying the stoppers. Only the surfaces of the electrodes facing each other were left uninsulated. The electrodes of the four tubes were arranged in parallel with four 110 volt incandescent lamps, one for each tube.

100 cubic centimeters of distilled water is placed in each tube, and to the water in the first tube is added 4 cubic centimeters of

half normal hydrochloric acid, to the water in the second tube is added 4 cubic centimeters of half normal sulphuric acid, 4 cubic centimeters of half normal monochloracetic acid is added to the water in the third tube, and 4 cubic centimeters of a half normal solution of acetic acid to the water in the fourth tube.

A 110 volt alternating current is passed through the four solutions, the electrodes being arranged at such distances apart that the filaments of the incandescent lamps glow with equal brilliancy. The conductivity of the acids passing from greater to less is found to be in the order hydrochloric, sulphuric, monochloracetic and acetic.

The acids are neutralized by the addition of a normal solution of potassium hydroxid and the conductivity of the resulting salt solutions is found to be nearly equal.

For the original paper on experiments 2 and 3 *see* Am. Chem. Soc. Jour. 22:726.

Experiment 4

The object of this experiment was to show that the cupric ions and SO_4 ions pass through a solution with different velocities.

Two small copper plates were clamped together in a horizontal position about $\frac{3}{16}$ inch apart and insulated from each other by pieces of hard rubber. The plates were then placed in a small glass cell made by cementing together pieces of picture glass.

An amount of a saturated copper sulfate solution sufficient to fill the space between the copper electrodes is poured into the cell and an electric current passed through the solution. An image of the apparatus projected on a screen shows the color of the solution to be at first a uniform blue but after the current has passed for a short time a light line forms near the cathode and a deep blue line developes near the anode.

Both electrodes being of copper it is obvious that the same amount of copper sulfate must continue present in solution during the experiment.

Section B. BIOLOGY

FIELD WORK IN HIGH SCHOOL BOTANY AND ZOOLOGY

BY EDGAR D. CONGDON, SYRACUSE UNIVERSITY

Since our estimate of the quality and amount of field work in high school botany or zoology is dependent on our conception of the content of the course itself, some statement of the latter seems to be necessary. To my mind it should include the following: the comparative study in the laboratory of the morphology and

physiology of the most important subkingdoms of plants and animals, broadened by field work whenever possible; a conception of the influence of environment on organisms, their plasticity and their activities. As a result, the student should acquire a general view of the science, a knowledge of local forms, scientific habits of thinking, and a sympathetic appreciation of living plants and animals.

There are other reasons, than those suggested above, why I believe in field work. A certain kind of training is obtained in greater degree by field work than by laboratory work. In the laboratory, we simplify conditions and eliminate nonessentials. We teach clearly how to deduce conclusions and how to develop generalizations. But is there any gradation in difficulty, or any attempt to closely correlate them with the student's degree of scientific training? I certainly can not detect it in many popular manuals.

Not only do we find in laboratory experiments little gradation of difficulty, but, in order to make the principles to be learned entirely clear, experiments are often made so easy as to call for no mental exertion.

Field work can easily be graded as to difficulty of problems. It can also offer problems of sufficient difficulty. It may be made to demand accurate but quick observation. In field work nonessentials are not removed, and the pupil must select from them the important facts, as he will be obliged to do later in real life. Problems may be suggested that he can not answer in a day, but may solve by time and patience.

There is a tendency in the laboratory to focus too much attention on the minute, to overspecialize. Particularly is this true with the more conscientious pupils. But out of doors, so many and such varied problems are continually forcing themselves on the attention, that the student must broaden and can not go too much into particulars.

Field work is needed to illustrate the principles learned in the laboratory, to broaden the ideas given by the study of a few types. On the other hand the study of plants and animals in the fields, while it illustrates general principles, is also effectually perfecting acquaintance with the forms themselves. Such a knowledge of plants and animals is worth the time of the high school graduate who goes directly into business. It also has a value to the college student as a basis for more theoretic work later. That it rouses interest, that it would be welcomed by many parents as a substitute for dissections, and, that it is the resource of many schools poorly supplied with laboratory equipment, goes without saying.

The conditions of the large city high schools, well equipped with laboratories but poorly situated for field work, and having large classes, are out of the province of this discussion. The speaker is not familiar with such schools and has nothing to suggest in regard to them: he refers only to the high schools in the smaller cities and the towns.

Those who do not favor field work in high school botany and zoology, urge various practical hindrances. One of these is the lack of time in the course and in the daily program. If it is necessary in order to give field work a place, I believe it worth while to reduce the number of types studied. Conflicts in the daily program may be obviated by selecting the last period in the afternoon, or the last two on Friday.

Unfortunately it is easy for field work to degenerate into a holiday and to fail in producing any clearly defined results. The remedy is to be found in the preparation of the teacher, in definiteness of the work outlined and of the results demanded. I believe that some of the topics of field study should be treated in a way similar to that employed in the laboratory. If the teacher has thoroughly acquainted himself with the material in the field, and has prepared questions calling for conclusions on definite subjects, I do not see why there should be any vagueness in results.

Lack of preparation is naturally a primary difficulty in the way of field work. When botany or zoology is one subject of several that are demanded of a teacher, the equipment of a specialist is out of the question. But field work is not. The study of plants or animals may be made a summer's hobby. The excellent popular taxonomic and so called natural history books at hand will relieve the subject of any drudgery. Confessions of ignorance will always occur in the field, but they need not be of harm to either teacher or pupil.

Thinking that it might be of interest to learn to what extent field work has been found practicable in this State, I sent letters to 75 city and town high schools of various sizes. In the 40 that did not answer, it is safe to say that there is little biology taught and less field work done. Of the 35 that answered, 15 gave a 20 weeks' course in botany yearly, four every two years and 14 at irregular intervals. Two schools gave 18 trips each. In 21, the number ranged from four to 12. 16 schools reported that they gave zoology. In 15 the fall course alternated with botany. 11 attempted three or four field trips each.

To my mind, two kinds of field trips are specially worth while. The first has for its object the illustration and expansion of the

facts of morphology and classification learned in the laboratory and the textbook; it is most valuable where laboratory facilities are poorest. The second and most important kind purposes to balance the study of structure by emphasizing the adaptations, physiology and ecology of plants, or the activities of animals. For these purposes, 12 trips seem to me fair under average conditions.

If lack of suitable material for field study is urged, are there not some topics that can be considered almost anywhere outside of a city? If the fall course is introduced by the study of seed, fruits and seed might be the objects of field excursions. Notes, and possibly sketches would constitute a suitable report. There should be included questions as to the significance of differences in shape and structure. Seed dispersal may be so used as to be of use as an introductory subject. Other distinctively fall topics are the method by which leaves are surrendered, the scars and associated buds. The study of coloring of leaves leads into a field too little understood even by the specialist himself. Food relations of plants, study of insectivorous, saprophytic and parasitic plants may be illustrated in many localities.

Even in winter we have a fertile problem in the branching habits of trees, their budding and its relation to form. The adaptations for protection of some spring flowers from the soil through which they pass, and from the winter cold, as illustrated by the Podophyllum and Sanguinaria, and the methods by which they are protected, give topics for the early spring.

Though we may not have a seashore flora, a swamp or a sand dune to illustrate striking plant families, we certainly have the roadside, the meadow or the pond. A fairly varied bit of woodland, under natural conditions is well adapted to illustrate the struggle of plant life for a foothold. The methods of seed dispersal or the effects of shading would make good topics. Many of our common weeds present problems that may be worked out by high school scholars. The long tap root of the dandelion, its rosette habit, its method of seed dispersal, rapid germination of seed and growth of flower stem on the maturity of the seed could be appreciated as causes for its success in the plant society.

Several instructors reported that they found pollination studies in the field practicable. The determination of the significance of flower structure and, possibly, the examination of insects found on the flowers, are subtopics.

Besides these lines of field study that emphasize plant activities, a series of topics on plant structures, to supplement the

morphologic study of types, is practicable. A field study of cryptogams has particular value in opening unexplored territory, even to pupils fairly acquainted with flowering plants. One city instructor emphasizes them as helpful in teaching his pupils how to observe. Comparison in the field of many types of inflorescence will incidentally give facts as to the method of classification of spermatophytes. Observation of variations of stems should be accompanied by a study of the meaning of their differences. Another topic is found in the ordinary types of leaves, and in the modification of leaves for unusual functions.

It does not seem to me that herbarium collecting gives adequate returns for the time spent. Eight or 10 plants very carefully prepared, are of value to a high school herbarium, and their preparation is sufficient to teach methods of analysis. Indeed the ruthless tearing up by the roots of many plants, the handling of them, crumpled and withered, must seriously threaten any budding respect for the plant as a thing of wonderful structure and activities. It has been suggested that a small series of plants or organs may be preserved to illustrate such topics as leaf modifications, phylogeny or economic values.

Zoology field work is rendered more difficult to plan than that of botany because of the great variability in amount of animal life. The subjects of study mentioned in answer to my letters are birds, insects, ecology and forms later to be dissected in the laboratory. One instructor speaks of marked success in field study, while three others think that it should not be attempted at all.

The question suggests itself, are not unsatisfactory results partly due to the absence of that preparation and definiteness of subject that are taken for granted in the laboratory? No outline is prepared, the locality is not examined by the teacher and no specific place is given to field work.

The lack of time has already been suggested as a cause for the omission of field study. Twenty weeks is all too short to allow a general survey of the field of botany or zoology. Yet it seems to me that the dissection of more than one vertebrate is not essential. Certainly study of such an aberrant group as the echinoderms ought not to crowd out the knowledge of the animals of one's own neighborhood.

The greatest difficulty in zoologic field work is the finding of suitable material near to the school. The answers I received covered this matter pretty fully. There are a few localities so destitute that it is almost impossible to find satisfactory material. Some topics of study however can be attempted in almost any place. A

few, at least, of the types dissected in the laboratory can be found in nearly every locality. Their habits and the relation of their activities to their structure can be studied in the field.

In the fall insect life affords a most practicable means of studying animal activities, for illustrating diversity and specialization of structure, and teaching principles of classification. The careful observation of some species of five or six insect orders and the collecting of them serve for several field excursions. In the laboratory the general external characters, wings, legs, and feeding apparatus may be studied. The first object would be to illustrate facts of adaptation of organs to their uses. Principles of classification can be illustrated by leading the pupil to form a tentative classification, followed by an identification of some of the insects. The study of a few species of one order gives very similar results.

Observation of the life of a field or pond can be so managed as to suggest the food relations of animals, diversities of habits of those of the same area and other ecologic topics.

It is easy to call to mind a series of topics that, though they would tax the instructor's knowledge of the material at hand, might most satisfactorily emphasize the dynamic viewpoint. Such are protective form and color, animal society, domestic life and industries.

It is unfortunate that, for obvious reasons, our fall courses miss bird study, so practical and profitable in the spring. The enthusiasm which it excites is not its only value; on it may be based questions of habit and instinct and principles of classification.

There is then real opportunity for high school biology to illustrate the activities of plants and animals in their homes. A proper preparation for such work will require no small expenditure of labor. There will always be vexations and uncertainties as to material and weather. But if, as our reward, the pupil develops a permanent interest in living things, some knowledge of them at first hand, and a view of biology not one-sided and bookish, is it not worth the effort?

Section C. EARTH SCIENCE

INDUSTRIAL GEOGRAPHY

BY MRS CARRIE L. RECORD, FREDONIA NORMAL SCHOOL

The geography of 30 years ago with its dull routine of map questions is behind us. Today, geographers are emphasizing the scientific aspect of the subject which puts new meaning into "the

description of the earth's surface." In these days the question why is being asked in geography and the answer to the question is leading us into rich fields of thought and investigation.

If we accept the definition, "Geography is the study of the earth in its relation to man and life," then that must be good geography teaching which, in the study of life consequences, seeks to show their relation to earth causes, while in the study of geographic conditions, such teaching would endeavor to point out the effect of these on certain existing forms of life.

The emphasis which modern geography puts on cause and effect places the subject at once on a scientific basis and gives a great controlling thought to the study. This underlying principle tends to unify and thus to simplify a great mass of material and to present as a related whole otherwise disconnected facts.

Of all forms of life which the earth presents to us, by far the most important is man—man at work. Human activity appeals to children in a special manner. This fact gives to the teacher a suggestion as to the best method of approach to a subject which shows on the one hand how people live and work and on the other hand why they live as they do. If, then, knowing the child's interests, we follow these as we help him to think accurately and scientifically, our work must be pedagogically strong. Such an opportunity is afforded in the study of industrial life.

As we enter on a discussion of this subject, let us get an idea of its meaning and scope. First of all, let us state what it does not mean. Industrial geography does not mean the mere naming and location of certain cities in this and other countries, giving a list of the industries carried on in each. Such a plan is as monotonous as the old time method and quite as barren of results. Again, the teacher who has listened as a child has tried to describe what he has seen in mills or factories is quite sure of the fact that the study of industries should not include many details of processes. Of course, the child is deficient in language power and on that account he may not be able to tell what he has seen, but he convinces us that the impressions he has received are vague and indefinite. He can not analyze closely, he must see the broad outline of things, hence he should be directed to those larger, clearer pictures which he can comprehend. We would not overlook the fact of the genius of man in industrial life. It is man who has made the desert to blossom and bring forth abundantly, who has levelled the mountains and spanned the rivers, yet we may recognize this genius without trying to understand how everything is done.

On the other hand, it is important that, in the study of manufactures, the child should see many of the products in the different stages of manufacture, specially when these have commercial value. Collections of such materials are available for schoolroom use and are of great value in getting correct impressions of things.

Industrial geography includes the study of those forms of human activity which are possible in a given place because of certain geographic conditions which exist there. For example, in the study of paper-making in the Adirondack region, the pupils should know that the presence of spruce wood in the forests of that section, the waterpower available there, the market which the great New York newspapers and other periodicals furnish for the product, together with the ease of transportation to that city, make the industry possible and profitable.

Some one has criticized the industrial phase of geography because it makes prominent man as a producer and trader, thereby emphasizing the already too great commercial spirit of the age. No one will deny that the industrial life of the present day does absorb much of the energy and thought of multitudes of people and it will continue to do so, so long as people in one part of the world produce something which those in another part of the world need. It is this very need, however, which gives the teacher an opportunity to emphasize the dependence of man on man. It is this thought of interdependence which will save the study of industries from degenerating into the mere consideration of buying and selling and getting gain.

It is our purpose to show how, throughout the course in geography in the elementary grades, industrial geography should absorb much of the attention of teacher and pupils.

The work in home geography is not complete without the study of the most important local industries, specially when these are earth-determined. The children have been made familiar with the facts of climate and soil, the slopes and drainage of their immediate neighborhood. They know many things concerning the industries themselves. The work of the teacher is to show the relation between these facts and to study the industries in their effects on life in the community. Let us suppose the industry to be grape-growing. How should the study proceed? First of all, it must be determined why the industry is possible, bringing out facts of climate, soil and drainage, together with ease of transportation to market. Next, attention should be called to the vineyard, the care it should receive, the kind of labor employed, the enemies of the vine and the effort

which growers must put forth to overcome these. The grape harvest with its hard work and its merrymaking are interesting features. The preparation for market and the transportation introduce us to some of the difficulties (many of which are also earth-determined) which the farmer must meet. The commercial value of the crop should be noticed, as evidenced by the wealth of many of the growers, their splendid homes, fine horses and carriages, and even automobiles. The benefits derived by a town situated in the midst of such a region are many. Trade is stimulated and social conditions are improved by the men of energy and thrift who are carrying on the business. On the other hand, the importation of foreign labor to perform certain parts of the work introduces many and serious social problems which affect church, school and state. Such a study with all the facts before the children should lay the foundation for a more intelligent study of the world at large.

Industrial life in the United States should claim the attention in the fourth grade. Here it seems advisable to study the most important industries of each section or group of states as these are taken up, instead of selecting centers of industrial life in the different parts of the country and grouping them under the various industries, as agriculture, manufacturing, mining etc. It is believed that the former plan is more systematic and definite, though the latter is exceedingly valuable as a means of summarizing. Only the most important industries in each section should be taught in this grade, and those should be preferred which are plainly earth-determined, the purpose being to give clear, definite ideas carefully selected and closely related. In the New England States, hardly more than a half dozen cities should be located and their industries and life studied. Among these should be Bangor, Lowell, Providence, Lynn, Gloucester, Boston. Such a study brings out other geographic facts as climate, soil, relief, drainage and coast line, hence the important rivers, mountains, bays etc. will be included. Life should everywhere be made prominent. Let us suppose that we are studying lumbering in Maine. Northern Maine becomes the seat of the industry and Bangor is chosen as a typical lumber center. The study includes the reasons for the presence of the industry, a knowledge of the principal kinds of forest trees in that region, when and how the logs are prepared for the mills, life in a lumber camp, log-driving and log drivers, reasons for the location and growth of Bangor, the distribution of the lumber and the uses made of it. Having a clear picture of lumbering in the New England States, pupils are ready when the Southern States are considered to make a comparative

study of the industry as found there. Likewise, in the North Central States and in Washington and Oregon this industry is important, and the attention of pupils will constantly be called to similarities and differences which grow out of physical conditions. When a summary is made pupils will be led to make a general statement concerning the geographic conditions which make this industry possible in any place. This will form the basis for the study of the same industry in other countries. It seems advisable also, in the first study of the various countries of the globe, to proceed in a similar manner, emphasizing only the most important facts. The child will thus be furnished with a clear knowledge (limited though it may be in amount) of certain definite facts, casually related, instead of an indistinct and vague notion of many details.

The work in the higher grades, notably the seventh and eighth, should of course be more comprehensive. Greater emphasis should here be placed on the physical side though cause and effect should not be lost sight of wherever these can be seen. It is true that some effects have causes so remote or so complex that it would not be possible, neither should it be deemed profitable, to try to trace the relation.

Pupils of more advanced grades are interested in the human element in geography because they are just beginning to identify themselves with the great life of the world. They would find profit in tracing the development of different countries through the various stages in which man has attempted to adjust himself to rapidly changing conditions. In our own country this involves the study of such topics as the industrial evolution of New England, the awakening of the South, the adjustment of industrial life to climatic conditions in the states of the plains, irrigation and its many related problems, the development of industrial life in the region of the Great Lakes, forestry and its relation to climate and industries, as well as the advancement in means of transportation in the last half century.

The boys and girls who go out from our elementary schools equipped with knowledge of this kind will carry with them also the power to think out other and perhaps greater problems which the future development of industrial life in this country may bring to them.

Attention is called to the map as an aid to such teaching as has been suggested for the elementary grades. Maps, including those found in the textbooks, as well as wall maps should be used extensively. Facts of location should be learned and pupils should be

encouraged to carry away with them mental map pictures. It is necessary in this work for the teacher to bring to the attention of pupils many other sources of information, such as geographic readers, pictures, magazines, and cabinets containing collections of materials in the various stages of manufacture.

Throughout this work pupils are called on to reason in a very practical way and they often find themselves confronting the same questions with which men of mature years are struggling. Sometime ago, while studying cotton-growing with a class of fourth grade pupils, the teacher told of the ravages of the cotton boll weevil and the importation of red ants to destroy the pest. A boy looked very thoughtful and then said: "They may be sorry some day if they do that, just as sorry as they are today that they ever brought English sparrows into this country." The Department of Agriculture questioned the advisability of the experiment on the same grounds.

The teacher of industrial geography has her reward in the task itself. Such a method opens before her many avenues of interest which her narrow professionalism may have closed. It broadens her sympathies, tests her power to reason carefully and accurately, and puts new meaning into the great throbbing life of mankind. It must follow, that as she tries to think as the world thinks, her power to train for citizenship will be increased.

Finally, since industrial geography will stand the test which scientific men are putting to the subject, that is, since it furnishes knowledge of the facts of geography, cultivates the power to think scientifically, creates a feeling of kinship with all the world, and prepares the pupils for life in a rapidly developing country, such a study holds an important place in our elementary schools.

This paper was discussed by Principal Clendenin of the Wadleigh High School, New York city, and by Dr Redway of Mt Vernon N. Y.

THE ESSENCE OF COMMERCIAL GEOGRAPHY

BY JACQUES W. REDWAY F. R. G. S.

Plus proderit demonstrasse rectam protinus viam quam revocare ab errore iam lapsos. *Quintilian*, 11, 6

Within the past three or four years a study that practically is a new one has been clamoring for a place in the school curriculum, and from present appearances, all the odds seem to be in its favor. The name commercial geography is not new. Nearly 20 years ago there was a demand for such a study in the schools of England.

Dr Hugh Robert Mill, an eminent geographer, prepared an unpretentious but most excellent elementary manual on the subject that appeared in 1888, and in the year following a very comprehensive treatise was published by Prof. George G. Chisholm. No general demand had obtained at that time in the United States for a text of this character; Dr Tilden's book was published about 1891, but its sale was ephemeral. At the beginning of the twentieth century the demand for a commercial text had become so decided that Mr Cyrus C. Adams, the geographic editor of the *New York Sun*, a man of international fame, published a high school text on the subject. From the moment of its appearance it was a success and obtained a wide sale all over the country. Coming at an opportune moment, Mr Adams's book has effected a quiet revolution of thought in the matter of geography-teaching that in the course of a few years will lead to a reconstruction in the methods of teaching the subject in elementary schools and will probably require the subject to be put into the high school courses.

Let us for a moment discuss the meaning of the term commercial geography, and the features in which it differs from the subject as ordinarily taught in the grades. In the school curriculum we recognize several divisions of the subject. For instance, there is mathematical geography which is not taught at all. It is an essential study in the science and art of navigation, but it has no place in common school work. Of much greater importance is the division for want of a better name called political and descriptive geography. This division, together with a superficial smattering of uncorrelated physical geography, has constituted the bulk of the work in the intermediate and grammar grades for the past 20 years or more. On the whole this division of the science is well adapted to the intellectual development of the boy, and with judgment and intelligence can be made the basis of a most excellent course of study. Moreover this development of the subject has led to a recognition of commercial geography as a separate department of the science of geography.

Thus, human activities are always the result of world relations. When the place is the center of attraction we call the study geography; on the contrary, if the man is the center of interest we call it history. The man is the center of activity because he is trying to adjust himself to his environment; he is striving to attain conditions that give him the greatest power with the least expenditure of time. Now, the friction that results in the efforts of the man to adjust himself to his geographic surroundings constitutes the

more serious part of history. It is right here therefore that we link history and geography—or, rather, that history and geography link themselves. Indeed, we may say that the two sciences differ only in the matter of placing the emphasis. If the place is right and the man's efforts are right, then the history is apt to be good and wholesome; but if the place is wrong and the man's efforts are misdirected for want of the "know how," then the history is pretty certain to be all wrong.

In the history of pretty nearly every people there has been a time when each center of population has been self-supporting; it is true of some today. Each community grew its own food stuffs and made, usually by hand, the commodities employed in everyday life. Things that they could not make themselves they went without. In the United States, even to within half a century ago, this policy was regarded as true economy; now we know that it is just the opposite. There is no economy in depriving one's self of that which will give increase of power; neither is there economy in making a thing that can be purchased for half the cost if made under more favorable conditions elsewhere.

There came a time, too, in the history of our own country when the man in New England discovered that he could buy for five or six dollars the barrel of flour that it cost him nine or ten dollars to produce. On the other hand, the wheat grower could purchase cloth, leather goods, machinery, and steel tools far more cheaply in New England than he himself could make them; indeed, some of these commodities he could not make at all. So he purchased them where they could be made most economically. Now it was not the fault of either man that he could not procure the respective commodities so cheaply as could the other; it was simply a question of environment. The rugged surface that made wheat-growing very expensive in the one case, yielded the water power that made manufacturing very economical in the other. Conversely the level surface and rich glacial drift that made the latter an ideal locality for wheat-growing, left all manufacturing industries that depended on water power out in the cold.

In other words, here were two centers of population that found it far more economical to purchase certain products of each other than to depend on their own resources. By this commercial interchange the people of each area extended their environment, and both were gainers by the transaction. Now this sort of interchange of products creates a new kind of human activity, namely commerce, and the history of commerce is the history of civilization.

A casual thought will show that the United States of today is less a federation of states, than one of industrial regions, each one of which is necessary to make the whole a world power. It is no longer a comparison of Massachusetts with Illinois; it is a matter between the center of textile manufactures and that of food production. Thus, the New England plateau is a region of manufacture and marine commerce because of certain topographic features and conditions. The middle and southern Appalachian region, together with the Huronian rangès of Lake Superior are now the world's chief center of structural steel manufacture. The gulf slope of the United States and the vicinity about it form an industrial section that yields three fourths of the world's cotton product. And so one might go on. The industrial features of the nation far outrank its political importance.

In the division of political geography the pupil studies the essentials of individual states; the division of descriptive geography consists of an oversight of general features, including peoples, places and industries; the department of physical geography considers the. various problems of topography and climate. The last named excepted, there is no sharply drawn dividing line that separates one division from another; it is a question of emphasis rather than one of fact. Moreover, one must make the same admission concerning commercial geography; its essential features are largely a matter of emphasis. It recognizes industrial regions without regard to political organization, except as the latter is either a hindrance or a help to commercial intercourse. But in a still more practical way, it is the geography of the dollar.

In commercial geography one can recognize no distinction between Massachusetts, Rhode Island, and Connecticut; each is a part of an industrial region, and the unity lies in this feature rather than in the matter of statehood. There is neither Illinois nor Mississippi; instead, there are the wheat-producing prairies and the cotton belt, of which each is an integral part. Commercial geography sees no barriers separating West Virginia from Pennsylvania; each is a portion of an industrial region whose activities have spanned the Asian continent from Moscow to Port Arthur with a double band of Bessemer steel. The Baltic plain is not German; it is not Dutch; it is not Flemish. On the contrary, it is the world's best locus for the production of beet sugar. Perhaps the man may have measured off a line and set up a tablet whereon is engraved the legend "This is Germany," or "That is Netherlands," but neither the line nor the tablet count for much. The royal crown is a pitiful fabrication; the real signet is the seal of the sugar cartel.

Commercial interests overcome even race hatred. Macedonia is rebellious, not so much because Turkey is cruel, but because they have no business interests in common. In Austria-Hungary race hatred is far keener than in Turkey, but it is forgotten long enough to pass the grain-laden boats from the plains of the lower Danube along the line of the least lift, to the manufacturing centers of western Europe. "A trade route," they call it; yet it is this same trade route that holds the Austro-Hungarian monarchy together. Take it away and the paper tinsel crown at once collapses by its own weight. Perhaps that crown may be imperial, but the strength of empire resides in the physiography of the Danube, and not in the gilded surface of the royal coat of arms. Manchuria is not unwilling to be amputated from the moribund trunk of China, and grafted on the more vigorous stock of commercial Russia; for no matter what political Russia may be, commercial Russia is straight and honest.

Markets are no longer inclosed by political boundaries. That used to be the rule a century ago, but now we know it to be a most stupid one. Reciprocity, which is another name for altruism, is becoming the great law of the world. A monopoly whose existence must be backed up by tariff laws and Mauser rifles does not stand on a firm basis. One can not long keep his feet out of the trough if he herds with swine; and hoggishness on the part of a nation is no exception to the rule. The only sound monopoly is the one that is protected by brains instead of bayonets. Moreover, the threadbare maxim that "property is robbery" is an excellent motto for inhumanity, and it belongs in connection with the sty.

The daily wants of civilized man extend to all parts of the world. The necessities of an ordinary breakfast for a family of moderate means include ware made of silver from Nevada or Colorado, porcelain from Japan or China, linen from Ireland or Flanders, coffee from Java or Brazil, sugar from Cuba or Hawaii, flour made in Minneapolis, meat grown in Texas, and spices brought from the East Indies. Even the water is conveyed in mains a distance sometimes exceeding 70 miles. In the preparation of the food one must have utensils made from ore of the Mesaba range plated with tin from the island of Banka, and cooked with the heat of coal mined in Pennsylvania. A savage may command his living from an area whose radius is five or 10 miles; and this fact insures his being a savage. Civilized man demands that his supplies shall be drawn from an area 12,000 miles long and wide; moreover, he is civilized because of the length of this radius and not in spite of it.

The great problems of the world today are those which concern the breaking down of commercial barriers and the removal of such

obstacles as impede free intercommunication. Modern civilization demands that anything, real or ideal, that hinders a rapid distribution of commodities is a public nuisance. Whoso for one moment retards the movement of a single grain of wheat on its way from the producer to the consumer is a public enemy and a malefactor to be put out of the way. During that moment he puts the brake on human activities that extend from the Black sea westward to the gulf of Pechili. Yet in this great Empire State we have recently voted to spend more than $100,000,000 for a canal to carry half the freight in double the time required by a railway costing hardly more than that amount. To send a bushel of grain from Chicago to New York city by an all water route costs about five cents; to send it to tide water by an all rail route costs not far from 14 cents, when rates are normal. Yet in the larger number of cases the shipper sends the cargo by rail at the higher rate because it pays. And the reason therefor is obvious; the only true economy is economy of time. The unnecessary expenditure of time is a barrier to commerce, and therefore the geographic conditions that make the saving of time possible are included in the problems of commercial geography.

Now these are the several classes of problems that go to make up the study of commercial geography, and in them we may recognize at least three phases of activities; first, those that are the immediate results of environment—that is, of climate and topography; second, the distribution of products along lines of least resistance—that is the transportation of commercial products to the most available markets; third, the mutual relations of peoples who must depend on areas external to themselves for the necessaries of life. It has been claimed that the second and third categories belong to the domain of political economy. Professor Davis and the Harvard school of geographers incline to this opinion; Pres. G. Stanley Hall is certain of it. But the facts of the case are that political economy is only a generalization of commercial geography. Moreover the latter is the only proper introduction to the former, for the one is the concrete form of the study of the well being of man, while the other is its abstract form.

It is hardly necessary to add that the problems of this sort are the things that young men and women ought to know, and whether or not they belong to the science of geography cuts no figure in the matter. One thing is certain; they constitute the application of geographic science to the affairs of human life. The only query then, is whether or not, after spending four years in the systematic study of geography, it is worth the while for a young man to apply

this knowledge to the actual life of mature years. In the great State of New York the question has been answered in the negative. At the end of the seventh year it is assumed that the pupil knows all of the subject that it is necessary for him to know; moreover he has triumphantly scored his 50 points in the examination grinds and the Alps are behind him; "feriuntque summos Fulgura montes."

There remains only the question of time and place for the study. The reply that neither time nor place for it exists may be brushed to one side; the pupils themselves have decided that question. They have already recognized the fact that it is the all alive geography of the dollar and the present day, and not a stale, cold storage product of a generation gone by. They are not only demanding it in the schoolroom, but they are calling for it from the library shelves as well. Railway men are asking for it and one great railway is placing it in the libraries of its system.

In an elementary form it is a most excellent study for the eighth year of the grammar school, and Mr Adams has prepared an excellent elementary text for this purpose. It is naturally a correlation of the history of the United States, for our national history has been but little more than a commercial struggle, and so also was our colonial history. In several of the Western States this view is accepted and the schoolmen are basing their courses of study on this plan. In most of the schools of New York, however, the study of geography has been eliminated from the eighth year, and the high school offers about the only place for the study. But commercial geography requires a maturity of mind that is not apt to be found in grammar school pupils, and in this State, where the system of promotions carries into the high school a large number of pupils who ought to have at least one more year with the nursing bottle, the first or the second year of the high school is perhaps the best place for it. With commercial and physical geography in the high school, the general course of study in the subject might be arranged as follows:

1st, 2d, and 3d years. Oral and observational work for the purpose of learning geographic forms and training the perceptive faculties, and also as a preparation for the laboratory work of succeeding years.

4th, 5th, and 6th years. The memory work and study of location, as treated in the ordinary elementary textbook.

7th and 8th years. The political and historical aspects of the subject, specially with reference to the great commercial powers and their dependencies, and also with reference to the history of the United States.

With a broad supplemental reading in both geography and history a course of this sort would give a pupil what he does get in the German schools, and what he does not get in the American schools, namely, a good general knowledge of the relation of mankind to his environment.

This paper was discussed by Frank L. Bryant, Erasmus Hall High School, Brooklyn; William L. Morrey, Morris High School, New York city; and W. W. Clendenin, Wadleigh High School, New York city.

AN APPARATUS FOR SHOWING THE DIRECTION OF SUNRISE AND SUNSET

BY FRANK L. BRYANT, ERASMUS HALL HIGH SCHOOL, BROOKLYN

[Abstract]

There seems to be a demand for definite laboratory exercises in physiography. Such exercises should aim to give to the student clearer knowledge than could possibly be gained from books. The time element should be carefully considered. If results are not commensurate with the time consumed, the exercise should, of course, be cut from our list and a better one substituted.

A simple apparatus consisting of a graduated meridian circle, three sun path circles with hour marks, a movable horizon, pole direction rod, and zenith pointer, has been constructed, which furnishes three exercises as follow:

1 To determine the length of day at any time of year in any latitude

2 *a* To show the position on the horizon where the sun rises or sets at any time of year in any latitude

b To measure the zenith distance of the sun at any time of year in any latitude

c To find altitude of pole at any latitude

3 To plot the daily shadow curve cast by an upright post in any latitude, at the time of the solstices and equinoxes

In the first exercise the time of the sunrise and sunset is read by means of the hour marks on sun path circles, and the length of day consequently determined. The variation in length of day at any place and the relation of amount of variation to latitude are clearly brought out.

The student in the second exercise will find the relation existing between the length of day and the distance in degrees that the sun rises north or south of due east. The variation of zenith distance

of sun at different times of the year, is easily found by simply reading the number of degrees marked on the meridian circle.

The student in this exercise will gain a realizing sense that the altitude of the pole equals the observer's latitude.

The third exercise furnishes work in plotting curves. By placing a straight edge on an hour mark and extending it over the top of the post to the paper, a point in the shadow curve is located. By using all the hour marks for the day, as many points are found. These points are then connected by a smooth curve.

The interpretation of these curves brings out many interesting facts. In this latitude the length of time the sun's rays fall on the north side of buildings; the area covered on floor by sun's rays falling through a south window at different times of the year; the relative lengths of shadows at different times of day and year are clearly shown. This exercise also furnishes a study in conic sections. The shadow curves are found to pass in form from the straight line to the hyperbola, through the parabola and the ellipse to the circle.

ADAPTABILITY OF PLANT GEOGRAPHY AS A SUBJECT FOR HIGH SCHOOL COURSES

BY W. W. ROWLEE, CORNELL UNIVERSITY

The present generation of teachers of natural history has witnessed a great change, both in the subject-matter taught, and in the methods of teaching. In botany this change has been almost revolutionary, because of the firm hold that the earlier method had on the schools. The aim was to learn, too often "by rote" from textbooks, lessons dealing almost entirely with the organography of the higher plants; to give some familiarity with the glossary of terms describing plants; and some practice in the use of analytic keys in determining species.

For this work the laboratory method has now been substituted. The main purpose of our courses of study is to familiarize the student with the biologic facts connected with plant life as exemplified in the study of types, chosen usually so as to represent the larger groups of the whole vegetable kingdom.

The writer believes firmly in this method of study, but in this paper wishes to draw attention to a feature of the old method, always emphasized by the best teachers in connection with that method, and too likely to be neglected in connection with the new. The phase of plant study that I referred to, is plant geography.

When wild plants were determined by means of the manual, attention was of necessity drawn to the localities in which they grew, and the student was bound, even without encouragement from his teacher, to gain some impression of the distribution of the plants around him. The localizing faculty always plays a great part in our thought, and the impressions gained in the analysis of plants, superficial as that work frequently was, nevertheless remained with the student as a permanent acquisition and also as a stimulus to observe.

Plant geography may well be considered from two points of view: first, the distribution of plants over the earth's surface; and second, the agency by means of which they are distributed. The first is closely akin to geography and the methods pursued in teaching it can best follow the general methods pursued in teaching geography; the student beginning with the plant near at hand, and then proceeding to plants in more distant parts of the earth. The second is more particularly a biologic study and can be pursued most profitably in connection with, and as a supplement to, laboratory studies on the various physiologic phenomena connected with plant life. Great emphasis has been laid, in the last few years, on the second phase of plant geography, and by some it has been considered a distinct part of botanic science and been given the name of plant ecology. It is one of the most prolific fields for the pursuit of nature study, affording as it does endless opportunity to develop the powers of observation, to train students to accuracy not only of observation, but of conclusions as to the bearing of natural phenomena in general.

It is not this particular phase of plant geography however that it is my purpose to bring to your attention in this paper, but rather to emphasize what seems to me a somewhat neglected opportunity on the part of high school teachers. It is often the case, no attention whatever is given to the distribution of plants on the earth's surface; such study should begin with a careful survey of the locality in which the student is working. The kinds of plants of course must be learned, but whether this is done through the teachers telling the student the names (English or Latin) of the plants, or by their identifying them for themselves by aid of the manual, little matters. I feel that it is highly essential that they should know the particular kinds of plants growing in their own neighborhood. It may be objected that in the larger cities students can not have access to the woods and fields where plants grow in nature, and this certainly is unfortunate, but in the great majority of cases

students can make excursions to such places and as soon as they are there they should be impressed with the idea that they are not on a pleasure excursion, but rather to do a day's work, to find out not only what the plants are, but how they are arranged with reference to each other and with reference to the environment in which they grow.

It is best for the teacher to select a place, if possible, where two or more different types of vegetative covering present themselves, such as marsh and woodlands, so that somewhat striking contrasts may be shown. This will prove a most attractive study. The distribution of plants in zones will come easily as soon as the student grasps the idea that plants do not grow promiscuously, but form congenial societies beyond the limits of which they exist, if at all, only sparingly. They will also soon discover, besides zonal distribution, that horizontal distribution presents itself. We have distinct groups of plants forming a forest overgrowth, and another distinct class of plants forming a forest floor, with intermediate growth of shrubs always maintaining their position at a certain level.

The shore of sea, lake or river is one of the most attractive places in which to take up such studies; the zonal distribution there being most marked, and frequently in the landward stretches the woodland areas are immediately in contact with it. One day seriously devoted to studies of this kind will prove a great stimulus to students who have previously gotten their conceptions of plants in the laboratory; and a few or even one period of study will make permanent impressions that will last through a lifetime and will stimulate to further interest the observations on plant life, no matter what the future career of the student may be.

I have always felt that familiarity with the kinds of plants in a limited neighborhood and their arrangement with reference to each other and the land environment in which they grow, forms an indispensable basis for further work in botany. I am likewise of the opinion that such a course of study will be really as effective, both from the point of view of mental training and from the point of view of mental acquisition, as any other phase of plant study that can be given. It will become the standard of reference during the student's future life, and whether he adds to it by further studies in the university, or as in the great majority of cases, he immediately goes into the practical affairs of life, he will cherish this as a useful part of his education. The plants of the various parts of the world are so alike that he will, wherever he may be placed, be able to make comparisons with his studies in the high school course, thus

constantly widening his range of knowledge. If he has time to read and thereby widen his information about the world distribution of plants, he can read understandingly such treatises as Schimper's and others on plant geography. He can appreciate more readily works of travel and works dealing with the resources of foreign lands.

In conclusion let me say I would not favor the introduction of plant geography as a distinct high school course, but would commend it to the attention of the teacher as a phase of botany that may be brought into the high school courses as a supplement to laboratory work; the familiar illustrations afforded will make the laboratory work alive, practicable, and coordinated with everyday life.

Section D. MATHEMATICS

GEOMETRY

BY W. H. METZLER, SYRACUSE UNIVERSITY

One great question which interests every teacher is as to how he is to teach his subject. Before he can answer this question however, he must answer the question as to what the study of his subject is to accomplish for the pupil, and it is evident that before this can be answered he must know thoroughly what his subject is. In this paper on geometry, therefore, an effort will be made to consider in a general way answers to the three questions—What is it? Why studied? How taught? The largely suggestive character and lack of details in the paper will give abundant chance for a profitable discussion.

What is it?

Elementary geometry seems to have had its origin among the Babylonians and Egyptians as a practical necessity and though much advanced by the Greeks it was but a more or less disconnected set of propositions till Euclid something over 2000 years ago in his *Elements* collected and systematically arranged into a connected and logical whole the results of his own and earlier investigations.

One axiom—12, the axiom of parallels—in Euclid's *Elements* was not a self-evident proposition since the converse, proposition 17, admits of proof. Efforts to prove this axiom were made by some of the best minds of their time but all to no avail. Among others Legendre about 1733 tried to deduce this axiom from the others but of course failed.

The controversy between idealism and empiricism had been going on for some time but did not make much progress till Kant gave

it its modern form. Euclidean geometry was supposed to be the geometry of our space but in order to be sure of this either we must be certain of the truth of the premises on their own account or we must be able to show that no other set of premises would give results consistent with experience. The first of these alternatives was the position of the idealists and the second was practically that of the empiricists. The view of the idealists represented by Kant required that all the axioms be self-evident and hence the hunt for a new axiom to take the place of the one on parallels and which might be a priori. Many were suggested but none were self-evident but could easily be doubted. Kant said if geometry has indisputable certainty then space is a priori and purely subjective and conversely if space is purely subjective then geometry has indisputable certainty.

The second alternative stood until towards the close of the 18th century and during the early part of the 19th century new light appeared when Lobatschewski and Boylai independently carried out the method suggested by Gauss, though it is now known that it had been suggested nearly a century before by an Italian Saccheri. They said that if the axiom of parallels is deducible from the others that to deny it and retain the others would lead to contradictions. They did this but found no contradictions and obtained a logically consistent geometry. It was thus found that premises different from Euclid's could give results which within the limits of observation fitted our space apparently as well as his. The empirical argument for Euclid was therefore destroyed.

This discovery shed new light on the subject of geometry and gave it new life which was entered into by those who followed, notably Riemann, Helmholtz, Beltrami, Cayley, Kline, Peano, Hilbert and Russell. Investigations were made on deductive systems in general and an effort made to discover the underlying axioms. One of the difficulties of earlier investigations was that they were influenced by intuition. All reasoning, however, which is to be exact must be based on sure premises and proceed according to the principles of formal logic. Improvement came therefore through replacing the geometric concepts by pure symbols and dealing with them thus escaping the pitfalls of intuition. Peano with his students, Hilbert and Russell were perhaps the leaders in carrying out this method.

Russell in his essay on the foundations of geometry, published in 1897, showed that the following axioms of metric geometry are a priori:

1 Free mobility

Spacial magnitudes can be moved from place to place without distortion.

Relativity of position is the fundamental postulate of all geometry, to which each of the metric axioms leads and from which conversely, each of these axioms may be deduced.

2 Space must have a finite integral number of dimensions.

3 Axiom of distance

Every point must have to every other point one and only one relation independent of the rest of space. This relation is the distance between the two points.

The remaining axioms of Euclidean geometry viz, those that distinguish it from non-Euclidean geometries he considered empirical. They are the axiom of parallels, the axiom that the number of dimensions is three and that two straight lines can not inclose a space.

The meaning of this would seem to be that the remaining axioms of the geometry of our space are empirical. In other words it is only by experiment that we will ever be able to decide the nature of our space. We can, however, postulate a space and then consider the geometry of that space and it seems to me that is what we do or at least what we should do in elementary Euclidean geometry. These axioms, or perhaps we had better say postulates, are then not empiric and geometry is a pure science. This is in essence the position taken by Russell in his later work *The Principles of Mathematics,* published in 1903. The trend of modern mathematics seems to be in this direction and in the light of this trend it is interesting to note such statements as, " It is coming to be generally admitted that geometry is a physical science and that the truth of certain of the axioms instead of being necessary and self-evident is dependent upon the nature of space and our means of observation."[1]

We have but one space but several kinds of geometry so that if geometry were a physical science depending on observation we could have but one geometry. Geometry is either a pure science or else the study of actual space and it is the lack of the distinguishing between these two that has led to confusion and this confusion seems to be particularly marked in this country specially among secondary school teachers. If geometry were the study of actual space it would be an experimental science and should be conducted by means of careful measurements and the axioms of geometry thus considered should not be expected to be self-evident any more

[1] N. Y. Math. Soc. Bul. 3:8.

than the law of gravitation is self-evident. The latter yields observed facts and so does the axiom of parallels. Our answer, therefore to the question, What is geometry? is that it is a pure science or to quote the words of Russell, " Geometry has become a branch of pure mathematics, that is to say, a subject in which the assertions are that such and such consequences follow from such and such premises, not that entities such as the premises describe actually exist ". In other words we start with a set of postulates or hypotheses and build up in a consistent and logical manner our science on them. We do not know however as to the existence of the entities of these hypotheses. For instance in Euclidean geometry we postulate a Euclidean space but whether there is such a space in actual existence or not we do not know. We do know however that our space differs so little, if any, from Euclidean space that for all practical purposes we may consider them the same.

Why studied?

The subject of geometry is studied because of

1 Its value as a mental discipline

This has been recognized by every one and it would seem unnecessary to dwell on it but I would like to specify more in detail than is usually done, as follows:

a Concentration of thought

This is one of the most important powers of the mind.

b Clearness of thought and expression

Thoughts must be clearly in mind before they can be clearly expressed and they will be more clearly in mind after they have been clearly expressed.

c Ability to distinguish essentials from nonessentials

Much data is irrelevant to the solution of every problem. That which is relevant must be recognized, selected and used.

d Logical and accurate reasoning power

The student must learn to do independent thinking. He must force an argument to its conclusion and feel confident of every step in the process.

e Good judgment

By this is meant that power of the mind to sum up a situation in its true relations and this is what the student must do in connection with every proposition.

f Liberal mindedness

When the student comes in contact, as he does in geometry, with eternal verities, when he comes face to face with laws over which he has no control he appreciates more fully the limi-

tations of his own mind and is in a condition better suited to receiving the truth and the opinions of others. His mind is more open to the truth from whatever source it comes.

g Imagination—Visualization

Geometry has exceptional value in this direction.

h Memory

The meaning here is not verbal but rational memory.

The habit and power of associating ideas so that one calls up the other.

i Knowledge of the best processes for accomplishing a piece of work—Good mental habits.

2 Practical value of the facts learned

These are to a certain extent important but generally speaking they are of minor importance.

3 Its ethical value

The fact that a piece of mathematical work must be either right or wrong and if wrong the mistake can be discovered and must be corrected by the student and that a false step in a mathematical demonstration must lead to a false result and that correct reasoning must lead to a correct result is so close an analogy to moral life that the student gets an excellent training in habits of honesty and moral uprightness. I desire to emphasize this point because some people tell us that mathematics has no moral value. They say that in mathematics there is no opportunity for choice and therefore it can have no ethical value.

4 Mental enjoyment

That feeling of mastery or the power to overcome difficult problems and the ability and habit of thinking things out for oneself which are gained from the study of mathematics furnish keen intellectual enjoyment.

5 Esthetic value

It is not usual perhaps to speak of geometry as having value in training to appreciate the beautiful but I believe it is not lacking in this respect, particularly the beautiful in form and order as well as thought.

How taught?

Are we to teach geometry for its applications? by its applications? or as a science?

The applications of geometry are so unimportant for the average individual that I presume no teacher would keep that as an object prominently in view. If I mistake not, however, there are those who would have it taught by its applications to a large ex-

tent. It would seem to be quite impossible to get accurate notions or much of value in this way. It must be taught as a science and as a pure science which it is. This does not mean that the teacher is never to make any applications of geometric truths. Applications should be made and the student led in every possible way to see the value of the study and its relation to other subjects.

It goes without saying that unless geometry is properly taught the mere study of it without proper direction will not accomplish what it should. To say that the study of it usually produces all or even the greater portion of the foregoing results would be untrue. It would be impossible and unwise in the compass of this paper to go into detail to show how geometry should be taught to accomplish these results. If the results are kept clearly in mind then to accomplish them the teacher should for the most part be left free to work out the details as best suits his or her individuality.

As a preliminary to the study a course in drawing is very desirable. The habit of drawing neat and accurate figures is important particularly for the beginner and without formal definition he should in this way become familiar with many of the elementary geometric concepts.

Next should come a certain amount of observational or inventional geometry, but here a warning is needed. Care should be taken that students are taught correct notions of geometric truths which is sometimes not the case. For instance of two books on this subject one uses the surface of a body of water to illustrate a plane surface while the other uses it to illustrate that which is not a plane surface. From any books I have seen on this subject not only would the student get false notions of geometric concepts but he would get false notions of logical order and of what constituted a geometric proof. We need masters of the subject to write our books. Work in paper-folding and more drawing, including drawing to scale should find a place at this stage. Advantage would also be derived from the use of squared paper and the representation of phenomena by graphs.

Two geometric figures are equal when they can be proven so by logical reasoning and the student should understand that this is his only sure test of their equality. Units of measure have no place whatever in geometry and he should not be led to think, as is often the case, that he proves two geometric figures equal by measuring them with a rule.

The work in demonstrative geometry should be logically arranged and go from the simple to the more complex, new ideas being introduced as needed. The teacher must always keep in mind that it is geometric principles rather than detailed geometric facts that are to be learned. It is better to know the underlying principles than the detailed solution of propositions.

Definitions should be clear and accurate and the demonstrations should be simple and models of logical excellence and orderly arrangement. It has already been said that a unit of measure and therefore the degree has no place in geometry but we find it in many books.

The work should not only be logically arranged but it should be pedagogically introduced. First impressions are lasting and it is therefore important that a student's first impressions of geometry should be proper ones. Having correct ideas of the right angle, then to be asked the first thing to prove that all right angles are equal must impress most students as an attempt to prove that which seems to them as self-evident, and gives the impression that geometry is a matter of words. The first propositions presented for proof should not appear self-evident but be such as to seem to require proof.

Demonstrative geometry would best be begun without a textbook and the student should be led to discover in so far as possible his own proofs. In this way it will be found that they take the keenest interest in the subject and get a pleasure out of it unsurpassed by that derived from the study of any other.

If a textbook containing proofs is used a large number of exercises should be given and suggestions as to methods of solution and attack taken up with them. Those points which the student is likely to have too much difficulty with should be anticipated and lightened, care being taken to remove only so much of the difficulty that with good honest effort they will be able to complete the solution without discouragement.

If models are used care should be taken that they be used only to the extent of getting correct mental pictures of the figures. Otherwise much of the value of the subject as a training in visualization will be lost.

The student should be trained in forming the habit of first seeing clearly what is to be accomplished in any given proposition and then grouping together the possible ways of accomplishing the result with the resources at his command. The next step would

be to select the method which applies or applies best to the case at hand.

I should like to add in conclusion that the plan of completing first arithmetic then algebra and then geometry is not a good one. Time will be saved and interest gained by taking them more or less together. They should not all be begun at the same time perhaps but algebra should overlap arithmetic from below and geometry from above, and all should be more closely blended than at present.

Wednesday morning, December 28

SECTION MEETINGS

Section A. PHYSICS AND CHEMISTRY

EXHIBIT OF LABORATORY EXPERIMENTS FOR SECOND YEAR PHYSICS

This exhibit was planned and arranged by Mr L. V. Case, Tarrytown N. Y. It contained the following experiments, which were tried and explained in the laboratories of the high school either by the gentlemen in charge or else by pupils from Mr Kenyon's class in second year physics.

In charge of Mr O. C. Kenyon, Syracuse High School:

Estimation of tenths and hundredths of a division

Micrometer caliper

Curvature of lens with spherometer

Weighing by the method of Gauss

Velocity of sound in metal rods

Velocity of sound in carbon dioxid and in hydrogen

Overtones of rod fixed at one end and vibrating transversely

Matching colors with Maxwell's disks

Expansion of mercury relative to glass

Watts per candle of incandescent lamp run at different voltages

Magnetization curves. Strength of field by magnetic pendulum

Horizontal component of earth's magnetism

Testing of series, shunt and compound dynamos with the plotting of characteristic curves

Frequency of alternating current; sonometer method

In charge of Mr L. V. Case, Washington Irving High School, Tarrytown

Radio-activity measurements

Wave length of sodium light

A new method of producing Lissajou's figures

Magnifying power of compound microscope

In charge of Mr C. E. Harris, East High School, Rochester

Surface tension of soap water by rectangle and balance

Determination of tuning fork to within 1/5 %

E. M. F. and R of Daniel cell with voltmeter and ammeter (Weston instruments, type K)

In charge of Mr R. J. Kittredge, Erie Pa.

Value of "g" to within ½ %

Density of dry air

Absolute expansion of mercury

Curve of vapor pressure of water from 50° C to 100° C

In charge of Prof. William Hallock, Columbia University

Determination of angle of dip by reversing needle and magnetism

Determination of M × H and of M ÷ H

Capacity of condenser by comparison with standard using high resistance ballistic galvanometer

Self-induction of coil by comparison with standard using Wheatstone's bridge with steady and interrupted currents

In charge of Mr G. M. Turner, Masten Park High School, Buffalo

Law of efflux of gases (carbon dioxid and hydrogen)

Horse power and total efficiency of motor with varying speed

In charge of Mr N. D. Parker, New York city

Value of "g" to within ½ %

In charge of Mr E. R. von Nardroff, Erasmus Hall High School, Brooklyn

Optical lever—1/500,000 of an inch

Laws of transverse breaking strength

Compressibility of water with new piezometer

Determination of tuning fork to within 1/20 %

Measurement of wave length of inaudible sound (Rayleigh's method)

Focal length of lens with different spectrum hues

Diameter of lycopodium powder by diffraction pattern (Young's eriometer)

Study of colors of selenite in polariscope by means of spectroscope

Joule's mechanical equivalent of heat to within 5%

Angle of polarization of glass

Determination of moment of inertia by ring method

Thermo-electric series

Thermo-electric diagram

Heat equivalent of the electric Joule to within 2%

Brief descriptions of some of the above experiments follow.

Experiments shown by O. C. Kenyon

1 *Magnetization curves. Strength of field by magnetic pendulum*

A short, rather thick, magnetic needle is suspended inside an upright glass tube. This is then placed at some point in the field of an electro-magnet, the magnet being so constructed that its core may be removed.

The number of oscillations of the pendulum is taken, first without the core, for no current, then for various currents, these being measured with an ammeter. The same measurements are again made with the core inside the helix. The well known magnetization curves (relation of current to square of number of vibrations) are then plotted for the coil alone, for the coil and helix together; and, by subtraction, for the core alone.

Horizontal component; magnetometer method. See Sabine's *Laboratory Course,* p. 82-86.

Testing of series, shunt, and compound dynamos, with the plotting of characteristic curves. *See* Nichols' *Laboratory Manual.*

Frequency of alternating current; sonometer method

A wire on a sonometer is tuned till its frequency is the same as that of the current. The agreement in pitch may be shown (*a*) by a telephone receiver, shunting a very small part of the current through it and listening to its pitch, as compared with that of the sonometer; (*b*) by using a strong magnet placed so that the middle part of the sonometer wire passes through the strongest part of the magnet's field. When, now, an ampere or two of current is passed through the wire (use two or three lamps for resistance), and the bridge of the sonometer is properly adjusted, the wire will vibrate (principle of the motor). When the vibrations are a maximum, measure the wire's length.

Now tune the wire, keeping the same tension, to unison with a fork of known pitch; then by the law of length of strings, the unknown frequency is easily found. The results are accurate to about 1%, and the experiment is extremely interesting.

Strength of an electro-magnet; computing permeability from the force to pull the magnet and its armature apart, and the law of the electro-magnet (Flux = magneto-motive force ÷ reluctance). (The force = square of flux ÷ 8 π times the area of the cross-section, using c. g. s. units.) The core used is made of a ring of soft iron, nearly circular in shape and cross-section, sawed into

two parts, and ground so that the ends fit well together. A helix slips over the ring, which is held in an apparatus for breaking wires. With various currents passing through the helix, the force to separate the two halves of the ring is measured. From the values of the current, the force, the area of cross-section, the length of the magnetic circuit, and the number of turns of wire, the reluctance, magneto-motive force, flux and permeability for various degrees of saturation may be obtained. For pupils who have studied the theory of the electro-magnet, the experiment is very interesting and instructive.

Coefficient of self-induction

A direct current is passed through an electro-magnet and an ammeter in series. A voltmeter gives the fall of potential through the magnet. The resistance is obtained by Ohm's law.

Repeat, using an alternating current and alternating current instruments. The fall of potential required for the same current as before will be many times larger.

Compute the coefficient of self-induction (L) using the law of alternating currents, $C = \frac{E}{\sqrt{R^2 + (2\pi n L)^2}}$ (C, current; E, E. M. F.; R, ohmic resistance, obtained from the direct current readings; n, the frequency).

EXPERIMENTS IN RADIO-ACTIVITY, ACOUSTICS AND OPTICS

BY L. V. CASE, WASHINGTON IRVING HIGH SCHOOL, TARRYTOWN

Radio-activity

The apparatus consists of a brass cylinderic vessel about 20 x 30 cm with a removable base, which supports an adjustable platform 4 cm in diameter. The top has passing through it, a quartz rod insulated from the brass by amber. At the lower end of this rod, is a thin brass strip 8 cm long with a gold leaf attached. Also passing through the amber is a movable charging rod, one end of which may be brought in contact with the brass strip and the other with the high potential. On the opposite sides of the cylinder are V-shaped openings; by the side of the one nearest the observer is a degree scale which is reflected from the mirror beside the opposite opening and in which is also read the deflection of the gold leaf on the scale. As the mineral cyrtolite is within the range of the

instrument and yet shows a great difference in radio-activity in different specimens, it is used as our unknown and compared with a standard weight (100 mg) of uranium metal.

Wave length of sodium light

The method is practically the same as that described in experiment 91 of Ames and Bliss's *A Manual of Experiments in Physics.* The grating used is the photographic. The sodium light is produced by soaking blotting paper in a solution of NaCl solution and winding it around and projecting above the tube of the Bunsen burner.

A new method of producing Lissajous' figures

Apparatus consists of a pair of chains joined by a clamp of peculiar construction which admits of a quick change, yet holds the two chains securely fixed at any desired position. A heavy pendulum bob with a vertical hole passing through it at the center, through which freely slides a stylus filled with ink. The bob is supported by a string fastened at a point midway between the two chains and passing through the clamp in such a manner as to readily admit of a quick adjustment of the length of the pendulum. When the pendulums are oscillated, a complete harmonic curve is traced in ink on the notebook paper. Giving a point the value of one and a loop two, the lengths of the pendulums will vary inversely as the squares of the values of any two adjacent sides.

EXPERIMENTS IN VAPOR PRESSURE AND THE VALUE OF *g*

BY R. J. KITTREDGE, ERIE PA.

Experiment for the determination of the value of "g" to within ½%

A Kater's pendulum was used for the experiment. It consisted of a round brass rod over a meter in length and having two movable clamps through which two screws pass. One of these is on each side of the rod and they support the rod so it may swing as a pendulum. The points of the screws are sharpened and rest in a cut in a split piece of brass suitably supported.

Another form which has proved very satisfactory is made of the ordinary meter rod. Near one end a piece of iron filed so as to give a knife edge is driven. At about 30 or 40 cm from the other end

another similar knife edge is driven. Any piece of metal clamped to the rod will serve as an adjusting bob.

The experiment is performed by so adjusting the clamps or bob that the pendulum swings in the same time on either knife edge. The only reading left to take is the time. This can be done in any of the ways common in the laboratory. The results with the above meter rod device come within .2%.

The curve for vapor pressure was performed with the common Boyle's law apparatus. The free tube is supplied with a few cc of distilled water and surrounded with any convenient water jacket. This is slowly heated by heating the water in the jacket till the water in the tube is partially vaporized. A thermometer should be so placed as to give the temperature of the vaporized water. At first the open mercury column is placed below the other. The difference in mercury level and temperature are read at intervals and the curve plotted. The abscissas should represent temperature and the ordinates pressure of water vapor.

EXPERIMENTAL CONTRIBUTIONS FROM ERASMUS HALL HIGH SCHOOL

BY E. R. VON NARDROFF, ERASMUS HALL HIGH SCHOOL, BROOKLYN

1 *Compressibility of water.* The compression tube consists of a small test tube fused to the graduated stem of a broken thermometer. It was filled with well boiled distilled water and provided with a mercury index. This is inclosed in a stout glass tube 25 mm in diameter and 400 mm long, and the space between the two tubes filled with water. Definite pressure was applied by a column of mercury contained in a piece of rubber compression tubing and reaching up to a glass vessel. By means of a cord and pulley in the ceiling this vessel could be quickly raised and lowered through a hight of several meters. Very consistent results well in agreement with the best published results are obtained.

2 *Moment of inertia.* A light brass tube about 17 mm in diameter and about 120 mm long was suspended vertically by 200 mm of no. 28 spring brass wire. Brass rings having masses from 50 g down to 1 g and having an average diameter slightly less than 1 cm (radius of gyration exactly 1 cm) had narrow slots cut in them by which they could be slipped over the wire and over the tube. A small cylinder of brass was first suspended in a horizontal position by springs from the tube and the number of torsional swings in three minutes counted. Rings were then substituted for the cylinder in

such amount that the swings were the same as before. The mass of these rings then represented the moment of inertia of the horizontal cylinder. The experiment was repeated with the cylinder supported to swing about its axis.

3 *Angle of polarization of water.* A pan of water with bottom blackened. A Nicol prism mounted on horizontal axis provided with horn protractor; the axis of the nicol was perpendicular to the above axis which was parallel to the longer diagonal of the *tr* nicol. The reading of the protractor was noted while the nicol was in the vertical position as determined by sight, and reflection from the horizontal surface of the water. The protractor was again read when the nicol being considerably tilted and the pan of water shifted toward a high window, the axis of the nicol intersected the middle of the black patch seen on the water surface.

4 *Optical lever.* This lever consisted of a three legged stool in which one leg was only .5 mm from the line joining the other two legs. To prevent upsetting the lever was supported on a plate glass shelf and was provided with a balancing weight by which the center of gravity of the system could be adjusted to come in the middle of the plane joining the feet. With telescope, mirror, and scale, thicknesses could be observed to within about one millionth of an inch.

5 *Diameter of lycopodium by diffraction rings.* A simple eriometer as invented by Thomas Young was constructed from a meter rod, cork and card. The card at the end of the rod was provided with a central hole about .5 mm diameter surrounded by a ring of eight finer holes. The instrument was standardized by means of diluted blood dried on a glass slip which was adjusted in distance so that the first red ring seen when the card was placed opposite a gas flame appeared coincident with the outer ring of holes. The diameter of the blood corpuscles was taken from the books. The diameter of other particles was then proportional to their distance from the card when the red ring coincided with the ring of holes. In the case of lycopodium this can be checked by examination with a microscope. The experiment is a very beautiful one.

6 *Thermo-electric series.*

7 *Mechanical equivalent of heat.*

8 *Heat equivalent of the Joule.*

ARE WE JUSTIFIED IN DEMANDING A SECOND YEAR IN PHYSICS IN THE HIGH SCHOOL

BY WILLIAM HALLOCK, COLUMBIA UNIVERSITY

It would seem that in discussing the points involved in this question the arguments naturally fall under three heads or subdivisions. First, on general pedagogic principles is it desirable, second, do the results already attained justify our claim, and finally points as to availability of teachers, expenses, time etc.

I believe that on general principles we are justified, because it is well established that at least a year is required to make the start, to learn the nomenclature, and it is in the second year that the real harvest begins. During the first year everything is entirely new, wholly different from any of the studies pursued up to that time. Up to this time the scholar has been taught that this and that are facts, observed phenomena, with practically no suggestion of a why or wherefore. Moreover those facts are more or less disconnected, uncoordinated. In the study of physics for the first time whole classes of phenomena are coordinated and correlated. General laws or principles are deduced and the student is brought face to face with principles and laws which know no exceptions, with a science as exact in the concrete world as mathematics is in the abstract; in fact with applied mathematics. The first year's work is but a hasty reconnaissance of the whole terrain. It can but serve to point out a few essentials and indicate the possibilities for future study. In the second year one can begin serious work and expect real work of the scholar. Many of the old observations are repeated with greater care and refinements. The novelty has worn off a little and the serious importance of the subject becomes evident. In the first year the pupil learns to walk in the science, in the second he can begin to bear the burden of serious thought. The practice of thinking becomes confirmed and the scholar acquires the habit of expecting rational conclusions, and of applying the touchstone of reason and common sense to his results. Again by comparison with other no less difficult studies is our demand reasonable?

No one would for a moment undertake to teach a pupil enough Greek or Latin to pay for the trouble if only one year were available. In fact in Greek three years are required in order to teach enough to be recognized for admission to college. Less will not be accepted. In Latin four years are demanded and jealously guarded. Any suggestion of a curtailment meets with a storm of opposition. And the classic teachers are quite right. They have inherited time enough

to really do something in their subject and they zealously hold fast their inheritance. If they ever lost it they would never regain it at the present day, nor win it de novo if they had not received it from generation to generation.

The case is similar with the modern languages. Many French and German teachers maintain that the profit of a single year in their language is but a trifle compared with what could be done and is done in the second year. All colleges of importance which recognize the modern languages for admission will not count less than two years' work.

Of course in mathematics and English still more time is required.

Why should science be expected to do twice or three times as much in a year as Greek or German or Latin?

Though most of the arguments here adduced are applicable to a demand for a second year in any real experimental science still they apply a fortiori in physics where either of the great subdivisions of sound, heat, light and electricity might well be considered a subject by itself.

Secondly, I believe that the results thus far attained amply justify our demand. Many mistakes have been made and it often seems as if the pupil obtained only a negligible amount of benefit either in training or subject-matter. Nevertheless when the whole field is reviewed I feel sure that very substantial work has been done. Not perhaps when some overloaded teacher of mathematics or English or even Latin was called on by the old-fashioned preparatory school to take the instruction in physics, but wherever the work was undertaken in good faith with even moderate equipment and a teacher who had at least a trace of interest in the subject, there real good has been accomplished. I feel justified in this conclusion by the experience of the past dozen years with the physics offered for admission to the engineering schools of Columbia. If I might be permitted to again make comparisons, I am sure our success is very creditable compared with what could be done in a year with Greek or Latin or even French or German. We accepted a year in good faith and I feel that we have so used it that we can justly say "we have done well with one, give us another."

A great mistake was made by the advocates of physics in emphasizing the informational value and the interesting character of physics. To be sure the pupil in a year does get information valuable and applicable to his everyday experiences, but it is so small a fraction of all that physics could give that our critics claim that it

is negligible. Again it was claimed that the pupil would be fascinated with the kaleidoscope of physical experiments. Now they find there is drudgery and work in physics they are disappointed, and we are blamed. Who ever claimed that a pupil was charmed with the first two years of Greek or Latin? Physics is just as good as any study for method in the high school, better than most and any information obtained is clear gain.

Thirdly, the question of teachers and expense and time. It is not expected that all schools will attempt this work. Only the strongest and best equipped; only those which can afford a teacher who really has some special knowledge of the subject. Moreover this will react to strengthen the instruction in the first year and induce students of physics to take up work in secondary schools. Teachers will be forthcoming if proper opportunities are offered. As to equipment too the difficulty is overestimated. The apparatus for the advanced work is less extensive and not so costly as that required for the beginners. Fewer experiments are performed, but with greater care, greater detail and accuracy. Often the same instrument which served to busy a beginner but a couple of periods will afford useful study for the advanced pupil for as many weeks.

The great stumbling block of the "schedule" is always brought out as last obstacle to the second year. Where are the four years saved for Latin? When a block of four years is gained by dropping Latin why should it be filled with a patchwork of four single years of science? Thorough work in any two would be preferable. A second year of physics would be much better for the average citizen for example than advanced algebra, Cicero, Virgil, a dribbling of a modern language. Time will be made for us when those who govern schedules are not wholly classical enthusiasts.

Thus it seems to me that on broad educational principles, in view of what has been accomplished, and the absence of serious obstacles we are amply justified in asking for the recognition of a second year's course in physics in those schools which are adequately equipped as to apparatus and teachers.

A NEW AND SIMPLE LABORATORY APPARATUS FOR ACCURATELY RATING A TUNING FORK'S VIBRATION

BY F. W. HUNTINGTON AND E. R. VON NARDROFF, ERASMUS HALL HIGH SCHOOL, BROOKLYN

The object of every experiment is to teach some principle. The principle involved in the present experiment is not only that a tuning fork has a definite frequency of vibration, but that this frequency may be definitely determined. With the apparatus now long in use in high schools this is not possible. The time-marking pendulum swinging across the smoked glass is incapable of precise rating, and on account of its record being made somewhat in advance of that of the fork, further error creeps in when the smoked glass is not drawn along uniformly. Beside this, the apparatus as usually furnished by dealers in school laboratory supplies is altogether too crude; the smoked glass runs in imperfect guides, and the tuning fork is too light in weight and too much out of balance. This, together with the uncleanliness connected with the use of smoked glass, and the trying effect on the eyes when crowded records are scrutinized, has thrown what might have been a good experiment into general disrepute.

Our first plan was to improve the details of the common apparatus, but later we saw we could do much better by completely modifying the design. The result lies here before you.

The tuning fork, as you see, is long and heavy. It is made of bell metal, and is capable of maintaining a greater amplitude than a steel fork of the same length and pitch. The rather great temperature coefficient of frequency attending the use of this metal is of little consequence. The fork at the bend has been so shaped that the energy escaping through the stem is a minimum. Hence, as you observe, the sound emitted by the fork is almost too faint to perceive, though the amplitude is great and the pitch sufficiently high. A most important feature in the construction of the fork is the balancing of its prongs so that the stem stands accurately at an antinode. This adjustment is accomplished through judicious filing at the end of one of the prongs. A mounted balanced fork will continue in vibration several times as long as a similar fork not balanced.

As this apparatus is intended for use by young beginners in physics, all the adjustments have been made as simple as possible. The fork itself is permanently fixed. Its recorder takes care of

itself. The latter consists of a fine brass tube-shaped pen working smoothly in a vertical hole in one of the prongs, and is supplied with red ink from an ordinary pen before taking each record. The time is marked by a pencil attached to a telegraph sounder, the pencil being fixed several millimeters to one side of the pen. A battery in series with a pendulum sweeping across a narrow trough of mercury furnishes the necessary electric pulses. As the pendulum when started will swing of itself for more than an hour, it is easy to time it with an accuracy of one in 5000.

The fork is started by inserting between its prongs this cylindric piece of hard wood having an elliptic cross-section, which is given a twist and then withdrawn. This process is much easier for the beginner than bowing the fork.

The record itself is made on paper tape stored on a reel and drawn by hand through guides. There is no difficulty in securing a record of 20 consecutive seconds, and which may be 50 feet long. Such a record would show an initial amplitude of about six millimeters and a final one of about one millimeter. In counting the record we crease the tape across the beginning of each second's mark, and, estimating the tenths of a vibration on each side of a crease (with skill hundredths may be estimated), these estimates are recorded directly on the tape itself. After estimating these residual tenths adjacent to all the second's marks, the integral vibrations between the second's marks are counted and recorded in the same way. It is generally noticed that the record displays two sets of alternate values. This is owing to the lack of perfect symmetry of the mercury trough of the pendulum. By taking the average of an *even* number of successive seconds, error from this source is entirely eliminated. Experience shows that with a 20 ohm sounder and a battery of three dry cells the oxidizing effect of sparking is insufficient to demand the use of a condenser across the spark gap. With the electric lighting circuit (incandescent lamp in series) the use of a condenser, which may be a small homemade affair, is absolutely imperative.

The accuracy attained by this very simple and easily worked apparatus is remarkable. With a group of seven pupils at their first trial, each individual preparing and counting a six second record, the greatest departure from the average of the group was $\frac{1}{40}$ of 1 %, while the least was only $\frac{1}{200}$ of 1 %. The satisfaction and pleasure expressed by the pupils in obtaining this fine result, as contrasted with the dissatisfaction and disgust observed with the older form of apparatus, leave no doubt in our minds that

if real interest in physics is to be won, badly designed apparatus must be excluded. The apparatus may be cheap, but it must be so designed as to yield definite and consistent results.

[The authors of the paper here ran off several records which were then distributed among the members of the section.]

EXPERIMENTAL DEMONSTRATION OF SOME OF THE PHENOMENA OF RADIO-ACTIVITY

BY GEORGE W. PEGRAM, COLUMBIA UNIVERSITY

[Abstract]

The paper was a brief review of the phenomena of ionization of gases, of the three types of radio-active radiations, and of the succession of radio-active disintegration products in the case of radium; accompanied by a number of simple illustrative experiments, the most important piece of apparatus being a leaf electroscope arranged for projection. The hope was expressed that the paper would serve to help dispel any notion that radio-activity is an unrelated wonder, needing a new kind of physics to deal with it; and that teachers of physics in high schools would become interested in experimental work with radio-active substances, since it requires comparatively simple apparatus, yet brings one in touch with that very important field of physics that deals with gaseous ions and electrons.

The radiations from radium and other radio-active substances have been studied chiefly by means of their ionizing action on gases. That the conductivity of gases is a temporary property capable of being brought about by various agents, such as a flame, an electric spark, the radiations from radium, was shown; and the nature of the ions taking part in the conduction of electricity through gases, the loss of conducting power by the recombination of these ions, and the meaning of "saturation current", were discussed.

Marckwald's radio-tellurium, deposited on a copper rod, was exhibited as one of the simplest types of radio-active matter, giving radiations that ionize the air strongly, but which were completely absorbed by a single thickness of paper when wrapped around the rod. These, the α radiations, are characteristic of what we now call radio-active matter and represent in all cases the greater part of the energy of radiation from these substances. These radiations consist of particles of twice the mass of the hydrogen atom, carrying a positive charge, and moving with about one tenth the velocity of light.

A second type of radiation, much more penetrating than the α rays, is obtained from some of the radio-active substances. The effect of these radiations from a glass tube in which was sealed some radium bromid was shown by their action in quickly discharging an electroscope. The α rays, though given off in abundance by the radium, could not have produced the effect, since they could not have penetrated the glass containing tube. These penetrating radiations are called the β rays. They are deflected by a magnetic and an electrostatic field, from which deflections their velocity and ratio of charge to mass have been determined. The β particles have a mass about one thousandth that of a hydrogen atom, are negatively charged, and moving with a velocity 60 to 97 % that of light. The β radiations are entirely similar to the cathode stream in an X ray tube, except that the velocity of the β particles is much higher.

A third, and still more penetrating type of radiation, accompanies the β radiation, namely the γ rays, which seem to be related to the β rays as the X rays to the cathode rays. As the β rays have a higher velocity than cathode rays, the γ rays are "harder" that is, more penetrating, than any X rays. It is the γ rays that are able to excite fluorescent materials after having passed through several centimeters of metal screens.

The complexity of a radium salt in its solid state, and the succession of radio-active products from the radium was briefly discussed from the standpoint of Rutherford's disintegration theory. Some experiments showing how the radio-active gas, or emanation, may be obtained from a radium solution, and transferred from one vessel to another along with the air were shown.

Section B. BIOLOGY

THE METHOD AND SCOPE OF A COURSE IN BIOLOGY FOR THE FIRST YEAR IN THE HIGH SCHOOL

BY CLARENCE W. HAHN, COMMERCIAL HIGH SCHOOL, NEW YORK

The planning of a course in secondary biology is not a task which calls for the invention of new theories relating to conditions assumed to exist, after the fashion of the schoolmen of the 11th century, who created exact data on which to erect great castles of hair-splitting logic. Not only must we establish the mental power of the student of high school age, and the adaptability of the subject-matter, but every proposed method of presenting our subject must be demonstrated as to its value, by usage or experiment, before we can claim to have a course fit to defend. Our exact data are insufficient, still we need not soar above established truths.

Let us consider first, the capabilities of a child at the average age of entrance on high school duties; second, the value of biology in the training of the student and in supplying useful information for his future life; third, the possibilities of bringing the two together and the verdict of experiment and experience as to which is the most successful. Finally, we will present a course which it is hoped is adapted to the needs of the case.

The mind of a child at the age of 13 is capable of appreciating all the parts and relationships of algebra, German, history or essay-writing. Reason, imagination, judgment, creative power and memory are sufficiently well developed for the mastery of such subjects. It has been demonstrated according to scientific methods that the power of creative thought is diminutive at this age and on the increase. The desire for knowledge, curiosity in other words, is, on the contrary, in full vigor. While at eight, reasoning power is but awakening, at 13 it is a well recognized accomplishment.

Whatever the faculties may be, which biology calls into activity, that they exist at this early age can only be inferred from indirect evidence. All teachers will doubtless agree that a child of 13 will comprehend the structure and relationships of a strange animal like amoeba or paramoecium, too small to be seen, eating but not as we eat, breathing, multiplying etc., all in its own peculiar way. Yet it requires an effort for the student to translate these impressions. They are capable of comprehending rather profound principles such as the struggle for existence, survival of the fittest, production of new species by isolation together with variability; also the functions of organs such as the digestive glands, cnemotocysts, nephridia; and complex structures such as that of the earthworm, the circulation of man. Some of these are, indeed, very difficult for a young person to comprehend clearly. Then we may mention conceptions which are clearly too difficult for a student of that age. An extensive classification or complicated organic structure such as the retina or brain, a series of comparisons extending over a number of more or less complicated types, such as the development of the mammalian heart from the aorta and gill arches of lower vertebrates; all these are too difficult for the high school pupil. In order to have significance to the child and to keep active in his mind only such faculties as are already developed at this stage of his life, and in proportion to their development, the subject-matter of the science should be so selected as to be constantly in proper relation to this

factor. Unfortunately, we have no accurate information bearing on this relationship and must plead that opinion and judgment are of little value. Experience alone should be the guide.

It has been demonstrated of the mind that, like a muscle or gland, use in any particular way, increases its ability to repeat the same process. Whatever psychic processes the science of biology is capable of calling forth, these will its study tend to promote and intensify. For the want of better data, let us recall the mental qualities which are sometimes perceptibly developed in those who have been engaged in biologic work for a long time. The memory, power of observation, comprehension, ability to follow up the inductive method of reasoning, the ready recognition of relationships of facts, of underlying principles, the judgment as to the value of evidence, are faculties which are noticeably developed in men of biologic training. We may then look to this science to arouse and develop these qualities in the child in proportion as they are called into use.

In addition to its training value, there is a valuable utility in the knowledge content of this science. Since the high school is destined to be the "college of the masses" to use Lloyd and Bigelow's expression, this factor should not be lost sight of. Many questions of domestic and public economy depend on simple biologic facts, which come easily within the scope of the high school course. Personal hygiene, a moral conception of sex, a correct conception of the laws of nature, a diminution in the artificiality of life due to inherited customs, and a substantial contribution to the humanistic culture of Herbart, are useful functions of biology worthy of mention. A course which ignores the training value of biology is no more deficient than that which fails to provide for these possibilities of serving the future man.

Five methods of presenting high school biology are or have been in use. These may be briefly summarized as follows:

1 Specimens are collected, classified, named and described and the names with other interesting facts, committed to memory.

2 A series of well selected types are exhaustively studied, specially as to their morphology. Huxley employed this method to the best advantage.

3 A still more exhaustive study of a single animal and a single plant, such as the earthworm and fern. Sedgewick and Wilson employ this method in the well known textbook.

4 Morphology, physiology, classification and ecology are developed separately.

5 For a series of types, the morphology, physiology, classification and ecology are developed simultaneously.

In practice it has been the experience of most college instructors, and secondary teachers as well, that systematic biology has failed to bear full fruit. If this is due entirely to the training which teachers themselves have received, it is possible that the older courses may have virtues equal to those of today. While this does not appeal to our judgment, there seems to be no better refutation on record, at least we know of no definite comparisons of the two systems carried out in a scientific way.

The exhaustive study of types is a method the superiority of which was demonstrated by Huxley. The universal acceptance of this method of teaching zoology is evidence of value based on careful trial and ultimate success.

The fern-earthworm course is clearly deficient in the utility which a high school course demands. That it has training value can not be disputed, but as we shall find it is necessary to present a large part of the field of biology, such a course does not bring the student into personal contact with a sufficient number of the typical illustrations of biologic principles. Hence it is necessarily either one-sided or coupled with extensive textbook courses, it lacks clearness, there being a dearth of illustration. For the high school pupil it would probably be dull.

The plan of developing morphology, physiology, classification and ecology separately has been criticized [Bigelow and Lloyd, *The Teaching of Biology*] on the ground that the student's conception of the subject is disconnected. The information as the student retains it is neither natural nor useful. These four characters of an organism are closely related. By separating them a dissected picture of nature results. We have no direct evidence that this is true so far as I know. A student's state of mind can easily be approached by analogy however. In a certain course of lectures, which I have in mind, a single principle was developed by means of a large number of separate examples relating to many forms of life. I find that considerable effort is required to dissociate these facts from that sequence of thought and utilize them in connection with the life history or structure of the animal or plant to which they belong. The mind can grasp a complex conception only when its separate elements are arranged in their proper relation at least once. The question, then, is, do we want the child to consider the digestive system, for example, of all animals at once or do we want him to consider one animal and all its related

systems together? The individuality of an animal or plant, or group of animals and plants is in question. We do want a student to make comparisons and to associate related parts and processes for the purpose of discovering general principles and relationships, but not at the expense of his conception of a living organism which should be definite, complete, with parts related and having a definite relation to its environment. This has been the experience of the writer in regard to college students and if true with them it is the more applicable to younger minds.

This end is accomplished by the fifth method above mentioned. For each type considered, structure function, relationships, etc. are developed simultaneously. The field of biology is so large, however, that in order to present the subject in college, this fundamental plan has been amplified by the introduction into lecture courses of a large amount of information with no relation to any particular type. It seems to be the prevailing tendency of college persons who have come to teach in secondary schools, to supplement the high school type course in a similar manner. This may be due in New York State to an effort on the part of the teacher to cover more completely the course planned by the Regents. The advisability of this is certainly to be questioned owing to the brief time usually given to science courses. That an examination is successfully passed by a majority of students thus prepared is scarcely a test of the value of the course. We have seen that the science should tax and develop many faculties besides memory, yet the examination lays far more stress on this element of the mind. A better test of the real training value of a course is that which most college instructors often have occasion to notice. A student who has had no preliminary biologic training is frequently no more helpless in taking hold of his work than another who has passed through a so called course of instruction. I have known several cases of this character wherein the power of the mind in the deficient student could not be brought into question. To whom shall we look then, for a judgment of these overburdened type courses? The call of college instructors for more thoroughly trained students seems to indicate the fallacy of much of our preparatory school work. Some colleges have already introduced practical laboratory examinations as an entrance requirement for their candidates.

The question can not be considered closed with this, in as much as the great majority of high school students do not go to college and should therefore acquire more information of a practical value.

This, of course, ought not to be at the expense of their general training, rather at the expense of their special biologic training as compared with the student preparing for college. But can such information be lastingly imparted when a crowded textbook course is only sparingly illustrated by a study of laboratory types? It seems reasonable to conclude that in order to combine careful training and the permanent acquisition of knowledge, the student should be kept in close touch with the objects and principles at first hand. In order to do this one must give up the hope of revealing to a class more than a very small part of the important facts of the science. In fact, the combined courses of studies of all our high schools taken together, omit quite as many facts and principles of fundamental biologic importance, as they include. Why, then, should we hesitate to cut out matter for the sake of better training and more permanent knowledge?

Yet I have found it possible and indeed desirable to supplement each laboratory type presented, with important physiology, systematic relationships, adaptations, and other general principles which relate to the laboratory exercises and in addition to emphasize economic and other aspects entirely foreign to the laboratory type, without decreasing the time spent in actual contact with the objects themselves. This can be accomplished by topical reports and textbook assignments for home work.

It is true that a course may be planned which is based on a carefully illustrated study of selected types and all facts demonstrated. Will it be equal in training value and permanency of instruction to a purely laboratory course? The practice of college teachers is here again an example worth our imitation for if it is better training for the advanced student so much the more is it for the beginner. And this accords with one of the long established principles of evolution so well expressed by P. V. N. Myers in these words, "The hand made the tool and the tool made the hand." He refers to those primitive conditions when man first came to make use of simple implements, clubs, stones, spears etc. The hand became more skilful and new uses of the crude weapons demanded better tools. Ultimately, the mind and skill of the hand reacted together, the tool was used for purposes which, without the tool, would never have been invented. Thus it is that in the child's hands new specimens and instruments awaken new thoughts. Instruments require skill, judgment, painstaking accuracy, knowledge of structure and, as these powers develop, the ability to interpret is called into play. And so on, a variety

of mental powers is developed in a way parallel to the development of intelligence in the human race. On the other hand, abstract thought, without a definite knowledge of structure to begin with, leads to just such vagueness as one experiences on reading a treatise like Quaine's *Anatomy of the Central Nervous System*, without having the dissections at hand to give definite form to their mental images.

There still remains the possibility that this whole matter of presentation and course of study may amount to naught if the teacher is deficient in enthusiasm either from lack of sympathy with the course itself or with biology in general.

As a suggestion of what a course of study may be which is in accord with the general conclusions here submitted, we have below a brief outline for a twenty weeks laboratory course in botany and for a like period in zoology. The conditions guiding us have been taken in the following order, adaptability to the child's mind, training value, botanic or zoologic importance and utility in the subsequent life of the student.

There are several good reasons for presenting phanerogams by several distinct types. In the first place, it is easier and more thorough in the end than the study of a number of examples of roots, stems, twigs, leaves, flowers etc., a plan well adapted to prepare students for analytic work. Indeed, it is an inheritance from that early stage of the science. The phanerogam is the most complex type, therefore should be presented in the simplest manner. By giving as many as seven types of flowering plants one is still able to omit much that has no bearing on the important principles of the subject.

Botany: laboratory course

1 **Algae.** *Pleurococcus.* Alive, stained—cell wall, protoplasm, nucleus. (Explain properties of living cell; the use of chlorophyll.)

Spirogyra. Linear aggregate, cell wall, protoplasm nucleus, chlorophyll bands and their function, living properties of plant cell, conjugation, asexual reproduction.

Fucus. Mass aggregate, cellular structure, differentiation, conceptacles, oogonia and antheridia (prepared if necessary), fertilization, differentiation of sexes.

Slime molds. Charts of life history—dry fruiting slime molds to be studied with hand lens.

Bacteria. One or two well stained bacillii under microscope, dictations and home work.

Mocor. Conjugation; *agaricus,* its relation to molds; *yeast* (also home work).

2 **Bryophytes.** *Polytricum.* Root, stem structure, leaf structure; sections to show antheridia and archegonia; seta, sporangium, section of sporangium, spores. (Explain protenema and alternation of generations, if prepared protenema can not be obtained.)

3 **Pteridophytes.** *Fern* (Pteris). Roots, rhizome, its structure, buds, leaves, their parts and cross-section, photosynthesis, sporangia, spores, prothellia (preserved, showing antheridia and archegonia, alternation of generations.

4 **Equisetinae.** *E. arivense.* Rootstock, leaves, nodes, strobili, spores, differentiation of sexes, alternation of generations, extinct equisetae of coal period.

5 **Gymnosperms.** *Pines.* Cross-section of stem, twig with leaves; male strobilus, pollen; female strobilus, seeds; adaptation; wind pollination.

6 **Angiosperms.** MONCOTYLEDONS., *Trilium.* Root (functions) stem: sections, function of parts, leaves, shape, venation, parts, cross-section, under surface, function; flower, parts and function of each, relation of parts to leaves; sections of ovary; pollen; **fertilization;** monoecious; [fruit, seed, germination.]

Corn. Root, root hairs of seedling, function, adventitious roots; stem, nodes, cross-section, function; leaves, shape, venation, function; flowers, monoecious; wind pollination; ear of green corn with silk in formalin; section of corn; test for starch; germination.

DICOTYLEDONS. *Ranunculus.* Root; stem; cross-section and function; leaf, form; flower (same as above); ecology.

Nasturtium. Root; stem; sections, twining, function; leaves, function, arrangement, light relations, venation, shape, under epidermis; flower, irregular, color, nectaries, relation to insects, cross-fertilization, pollen; section of ovary; fruit, kind, fate of ovules; seeds, cotyledons, plumule, germination and growth of plants in laboratory.

BIENNIAL. *Parsnip or beet.* Roots, taproot, secondary roots, bud; lengthwise section after soaking in eosin; cross-section after soaking in eosin; test for starch; stem, absent; leaves, shape, venation; flower-stalk, leaves, time of growth, function; flowers, inflorescence.

TREE. *Buckeye.* Root, function and form (from description); stem (photograph), method of branching, cross and lengthwise

sections of wood, function of parts; bark, growth and function; twigs, buds, leaf scars, arrangement of leaves, bud scale scars; leaves; flowers, inflorescence, parts; fruit (in alcohol) all parts; germination.

Maple. Review root; sections of stem for comparison; sap and maple sugar; twigs; flowers; leaves; fruit.

PARASITE. *Indian pipe.* Fungoid characters; relation to host.

Zoology: laboratory course

1 Invertebrates. PROTOZOA. *Paramoecium.* Preserved and stained. Nucleus, vacuoles, granules, mouth. Alive in thin gelatin, cilia; motion of protoplasm; verify structures seen in stained preparation.

Amoeba and miscellaneous forms from any source as means of giving inspiration and information: dictate properties of living organisms.

COELENTERATA. *Parypha* in watch glasses (or hydra on slides); stems and zooids, oral and circum, oral tentacles, manubrium, mouth, medusa buds; alternation of generations: show a Gonionemus. Cross-sections: ectoderm, mesoderm, and entoderm.

Metredium (hand razor sections). Ectoderm, entoderm, mesoderm, mesenteries, esophagus, coelenteron.

Simple coral. To show that lime is laid down in same position as mesenteries; coral rock formation.

ECHINODERMATA. *Starfish (dried).* Dorsel; papillae (function), spines (function), madreporic plate (functions), eye-spots; ventral; ambulacral groove, ambulacral feet (function), mouth.

MOLLUSCA. *Clam or mussel.* Shell; external, anterior, posterior, umbo, lines of growth, hinge ligament (function). Internal; hinge teeth, umbo, adductor muscle scars, pallial line. Internal dissection; mantle, muscles, foot, gills, mouth, anus, syphon, pericardial cavity, heart, intestine, digestive gland, stomach, kidney, cephalic ganglion, and physiology of each.

ANNULATA. *Earthworm.* External; prostomium, clitellum, segmentation, setae, sperm ducts, oviducts, dorsal aorta, nephridial openings, anus. Internal; digestive canal, septae, reproductive organs, brain and nerve ganglia. Sections. Body wall, cuticle, epidermis, muscle layers, body cavity, digestive tube, typhlosole (adaptations).

CRUSTACEA. *Crawfish.* Dorsal; draw and label parts. Ventral; draw one each of typical appendages with gills; draw diagram of internal anatomy.

INSECTA. *Grasshopper.* Draw side view bringing out all parts visible with hand lens. Copy diagram of internal anatomy. Draw mouth parts removed. Draw section of compound eye.

2 **Vertebrates.** FISH. *Perch.* External; eyes, nostrils, operculum with its parts, gills, teeth, scales and arrangement, fins, anus. Injected gill, respiration. Internal; draw dissection in alcohol of circulation; capillaries of frog's foot; explain circulation and respiration. (Emphasize circulation).

AMPHIBIAN. *Frog.* Nervous system, draw dissection previously prepared and placed in alcohol; diagram of nerve reflex; live frog; development, 5-6 stages of eggs developing into tadpoles, appearance of legs and loss of tail, explain heredity, relation to other animals. (Emphasize nervous system and development.)

REPTILE, LIZARD. *Phrynosoma or chamelion.* Scales, cloaca, leg joints, toes, claws, eyes and eyelids, nostrils, teeth; show young alligator; turtle's carapace; snake's skin. (Emphasize integument.)

BIRD. External; feather structure, adaptation; skin of robin or sparrow, ears, eyes, eyelids, bill, scales on feet, claws, joints, wings; compare parts with fish, reptile, man. (Emphasize adaptation.)

MAMMAL. *Dog skeleton.* Skull, vertebra, humerus, radius, ulna, hand (or leg), teeth, rib, (function of each relation to other vertebra).

Rat or squirrel. Dissection preserved in alcohol, heart and large blood vessels, lungs, alimentary canal, liver, diaphragm, spleen, kidney, ovary, testes, larynx, trachea, (function of each).

Beef heart. Diagram of circulation.

Sheep's eye or beef eye. Vertical longitudinal section, hardened; three layers, optic nerve, humers, lens, iris, pupil, ciliary muscles; diagram to show optical principle of eye.

Histology. Prepared preparations, muscle, gland cell, nerve cell and fiber, epithelium, bone, connective tissue, blood; also fresh blood. By studying exemplary systems in different types of vertebrates, a complete typical vertebrate type is constructed, at the same time the five great classes are brought into relation and comparisons can be made.

THE FORMATION OF A NEW SPECIES OF THE EVENING PRIMROSE; A DEMONSTRATION

BY J. E. KIRKWOOD

[Paper presented by Mr R. E. Wager]

Till quite recently those who believed in the doctrine of organic evolution have given adherence principally to two theories, the one founded by Lamarck, the other by Darwin. Both, of course,

have held to the view that the differentiation of species, both in animals and plants, has been brought about by gradual changes in their form and structure; that by this very gradual change new species have arisen from preexisting species. This process did not involve the extinction of the parent species but the new one arose as a branch, so to speak, on the family tree.

But these two theories differed in other and very essential respects. The view of Lamarck, to which we shall give but a passing glance, considered the change in the form or structure of an organism to be due to some need which that organism felt in order to adapt itself to its surroundings. Climatic changes, or some change in the nature of the competition which all animals and plants have to experience in the struggle for existence, it was thought was sufficient to bring about the degree of change in the organism, necessary to constitute a new species or variety. It is well known that plants grown under different conditions of moisture, illumination etc. differ very much in appearance both in shape and in structure, but in order to constitute a species the characteristics which identify it must be hereditary; they must be transmissible from generation to generation in all living things. But the transmission of characters acquired by changes in environment the Lamarckian school has failed to demonstrate.

The theory of Darwin proceeds on a different hypothesis. According to the Darwinian theory, nature seizes on accidental variations in animals and plants as the basis for species-making, and by a process of selection weeds out the weak and perpetuates the strong. It is a matter of common observation that no two plants or animals are exactly alike. Not only is this true, but we find in any given species a certain range in size, form, and structure, and our conception of a species is rather that of a type to which a certain part of the organic world conforms more or less closely. In some families of plants, however, the range of variation is so great that it becomes exceedingly difficult to identify any given individual as belonging to a particular species. In all this range of variation, then, it is conceivable that some variations would be advantageous and others disadvantageous. To put it in concrete form, suppose the plants of a certain species were given to varying in the matter of branching, some producing a system of branching that would permit of greater exposure of leaf surface to the sunlight than was possible with the others. Obviously the less favored would gradually be run out. The progeny of the stronger or better favored plants would partake in a measure of the qualities of their

parents and in the end a race of plants would be established considerably divergent from the ancestral stock. But in this case it must be remembered that the process is a very gradual one, involving possibly centuries of time. Again it is not necessary that the favorable variations be all in the same direction. The variations might have to do not merely with the branching system, but with the number of seeds produced within a single fruit, or with a chance variation in the form of a seed which would enable it to be carried more easily by the wind or other agencies, or in many other ways which would make for the perpetuity of the type.

But one objection to the Darwinian theory is expressed in the following question: why, if species have arisen by these gradual changes, do we not find transitional forms? Why are the limits of so many species so sharply defined?

The followers of Lamarck and of Darwin have based their conclusions mainly on comparative studies. Within recent years, however, investigation has turned more to experimental lines, and it is the results of these fruitful researches that I wish chiefly to call attention to today.

Students of evolution have for many years been coming more and more to the opinion that the origin of new species must be accounted for by abrupt and considerable changes, and not by gradual transformation. The occurrence of what the gardeners call "sports" was known to Darwin and others though it was not explained by their theories. Occasionally in the growing of plants from the seed there springs up some peculiarly different form, the like of which has hitherto been unknown. Such "freaks" as they are popularly called, or "sports," to use the gardeners' term, have frequently been seized on and propagated.

In the 16th century there arose a new species of the celandine in the medicinal garden of Sprenger, an apothecary at Heidelberg. In several ways it differed markedly from the form of that plant which had previously been cultivated there. Prominent botanists of that period were unable to identify it with any previously known form. During the following 300 years it has been found only in gardens or their vicinity where it had probably escaped from cultivation. And other cases might be cited.

Dr Hugo de Vries, professor of botany at the University of Amsterdam, has lately given us the results of his studies in what he has termed the mutations theory. Believing that the study of these sudden and marked variations might reveal the secret of the origin of new species, he began a series of experiments which lasted

over a period of 17 years. At the outset he made a thorough inspection of the plants around Amsterdam, Holland, with a view to securing the most promising forms for his work. This was begun in 1886 and carried on for several years, during which period more than 100 species were brought under cultivation. Only one of these was found a favorable subject for study.

This plant was the large evening primrose which had escaped from cultivation in a neighboring park, and was found growing wild in great abundance in a neglected field. The plants were numerous, thrifty, and rich in monstrosities. Not only was this true, but different varieties were also found and young seedling plants showed marked difference in form. A number of these plants were taken up and removed to his experimental garden. Here they were carefully protected and propagated from seeds.

The evening primroses are all of American origin. One of them is among our commonest weeds and is conspicuous in the month of August for its tall stem with bright yellow flowers. The plant used in the experiments of de Vries was the great evening primrose or Lamarck's evening primrose (Oenothera lamarckiana) which was cultivated in Europe as an ornamental plant as early as the 17th century. It was probably introduced into Holland from the botanic gardens of Paris.

In dealing with plants great pains were taken to produce pure seeds. To prevent crossing, paper bags were placed over the flowering shoots to exclude pollen from other plants. The seeds produced under these conditions were sown and the plants treated in like manner in succeeding generations. From these seeds several new forms were observed to rise. Nine species in all were observed to spring from the parent type, the evening primrose of Lamarck.

These differed from the parent form and from one another. The parent form grows to the hight of four feet or more. But among its progeny was distinctly dwarf form, about a foot in hight, which bore much smaller flowers and which came true to seed from year to year. The differences were mainly, however, in the form of the leaves and of the fruit and the flowers. The differences were not so great as between a peachtree and a plumtree, but are as great as those that separate different species of oaks or violets. It should be noted also, that the parent species, the great evening primrose, was not alone in the process of mutation, but some of its offspring likewise gave rise to other forms.

According to de Vries, the origin of species may take place by either of several different modes:

1 Progressive species formation by the acquisition of new qualities.

2 Species formation without the acquisition of new qualities, in which there are three cases

a Retrogressive species formed by the lapse of existing qualities

b Degressive species formed by the revival of latent or dormant characters

c By hybridization

We may now turn our attention briefly to the features of these different categories.

First, what is meant by the acquisition of new characters?

Every organism, plant or animal, is a complex of many different features or characters. The term character in this sense may be taken to mean such features as the presence or the absence of hair, or the color of the hair; the form of texture of the leaf which may be round or oblong, thick or thin, rough or smooth, tough or brittle; or such as the color of the flowers, the size, form, or structure of the fruit, which may be long and slender, short and thick, maturing early or late, etc. Now a given plant may be possessed of a given set of these qualities, which are transmitted from generation to generation through the seed and the repetition of these features in succeeding generations may go on unbroken through centuries, when suddenly there appears a new attribute or quality which the plant had not possessed before. To make it clear, a hypothetic case might be supposed in which a plant formerly smooth gave rise to a new form with hairy leaves and stem. The presence of hair is an additional quality not hitherto possessed.

Second, how are species formed without the gaining of new characters. In this case we may find that a quality becomes dormant or invisible. For example flowers that have been colored may become white. The quality of color therefore has become latent or dormant. The plants may thus continue to bear white flowers indefinitely without any considerable variation. But the quality of color must be regarded as only dormant and may again be revived.

The question arises as to how we may distinguish mutations from variations. The answer is that mutations are hereditary; simple variations are not transmitted from generation to generation or at least imperfectly so. Simple variations are abundant everywhere, mutations occur very rarely. Again, mutations have to do more with qualities or attributes; variation is concerned with changes

in the size or number of organs, or the size of the plant or animal as a whole. The one is qualitative the other quantitative.

In discussing the subject of mutations we are brought to the question as to what part natural selection may play in the process. A study of the facts convinces us that natural selection can have no influence in originating a mutation, or in other words it is not at all responsible for the formation of a new species by mutation. After a new form has arisen, the influence of natural selection may come in to determine whether it shall survive or perish, but it can have no effect in originating the change in form or structure which we call a mutation. Mutations may be and are both favorable and unfavorable; they are formed indifferently, it appears, in all directions but only those that are best suited to the surrounding conditions may become permanent, the less favored forms perishing. Among the new species which de Vries found among his primroses were some which probably could not have survived had they been left to themselves. One form there was which produced no pollen, and which could have seeds only when pollinated from flowers of another species.

The main points regarding the origin of species by mutations are:

1 That new species arise by sudden changes and not by imperceptible gradations.

2 That the new plant in order to rank as a new species, must come true to seed; otherwise the change is to be classed among fluctuating variations.

3 That mutations are very rare as compared with mere variations.

4 That natural selection enters in only to perpetuate the favorable and to eliminate the unfavorable mutations.

THE SCOPE AND METHOD OF SCIENTIFIC NATURE STUDY

BY M. A. BIGELOW, TEACHERS COLLEGE, COLUMBIA UNIVERSITY

[Abstract]

The subject was discussed under four headings: (1) what is nature study and how related to natural science of higher schools; (2) the scope of nature study; (3) the values and aims of nature study; (4) is nature study scientific?

1 The line between nature study and natural science should be, in the opinion of the speaker, on the basis of generalizations and principles which are fundamental in organized science. Nature study is primarily the simple observational study of common natural

objects and processes for the sake of personal acquaintance with the things which appeal to human interest directly and independently of relations to organized science. Natural science study is the close analytic and synthetic study of natural objects and processes primarily for the sake of knowledge of the general principles which constitute the foundations of modern sciences.

2 Under the heading, scope of nature study, the proposition was discussed that all elementary school studies of nature should be nature studies as defined above. At present some of our high school work, chiefly biologic, is nature study; but this is rapidly becoming a duplication of work of the lower school.

3 The educational values of nature study are similar to those of nature science, and may be grouped under (*a*) discipline and (*b*) information, along practical, intellectual, moral and esthetic lines. From these values we lead to the aims: (*a*) to give general acquaintance with and interest in common objects and processes in nature; (*b*) to give the first training in accurate observing, and in other simple processes of the scientific method; (*c*) to give pupils useful knowledge concerning natural objects and processes as they directly affect human life and interests.

4 Nature study presented according to principles advocated in the foregoing is in harmony with the methods and rules of science, and deserves to be called scientific. But it should stop short of the principles and generalizations characteristic of elementary science. [The full text of this paper will be published in connection with a series of papers by various writers in *The Nature Study Review*].

L. B. Gary—When speaking of the scope of nature study, we are reminded of the subject that a boy is said to have chosen for his first essay, "The Universe and its Surroundings". The possible scope of nature study is as broad as nature itself. The practical scope will doubtless be found to be much more limited. The specialist in natural science is prone to see in his own subject just the ideal thing for nature study. It is easiest and most important to him, consequently if not on his guard, he drifts into the opinion, that it is easiest and most important for the child.

As Dr Bigelow has so well pointed out, nature study has had numerous local centers of dissemination and consequently great variety of subject-matter. Is it too much to say that despite all this diversity, the drift has been toward the study of the one stupendous miracle-life, and those simple chemical and physical phenomena most intimately connected with it? I am aware that our friends the chemists and physicists may urge that this is a one-sided bio-

logic view of the question. In reply it may be said, What better material can be found for training young child life than lessons from life, be that life animal or vegetable? In fact a child's interest in inanimate things is most quickly aroused if your description of them is couched in terms of vital action and human interest. How could you arouse sympathy and kindness of heart if you were dealing with inanimate objects exclusively for nature study? Nature study lessons from plant and animals have many inherent advantages which can not be urged for the other natural sciences.

The adaptability of leaves of trees for nature study work was early pointed out by that veteran naturalist, Dr A. C. Apgar of Trenton N. J. Leaves are usually easily obtainable by the country or city child. Their lesson is obvious. Their story is written in large type. No microscope is needed. They are good forms for drawing, paper-cutting lessons and color work. The study of leaves naturally leads up to the study of flowers, or modified leaves, seeds and their distribution, and various simple lessons in ecology. The economic side may well be emphasized and the sense of self-interest, responsibility and ownership aroused by the cultivation of flowers, vegetables and fruits.

Among animals the study and care of the cat and dog as suggested by Dr Hodge is to be encouraged because most children have intimate associations with them as pets. Other domestic animals, when available, may well be included. It seems to me that insects and birds stand next in human interest and importance, in the display of animal intelligence and in availability and adaptability to the aims and objects of scientific nature study. We should not forget that many other groups of animals may be pressed into service according to the exigencies of the case in obtaining material, and furnish beautiful lessons.

Some acquaintance with and study of the forms that are repulsive, or are popularly considered dangerous might be advantageous, if it were so conducted as to lessen the natural and acquired timidity and nervousness that the average girl feels when she sees a worm, toad, snake or mouse.

As to methods we should insist that they be such as to accomplish the purposes so clearly outlined by Dr Bigelow. The great emphasis in scientific nature study is on the method of investigation, the inductive. But we should not be so prejudiced as not to have recourse to the deductive on occasion. The precise method does not matter so long as the results are obtained. Here is a free field for the originality of the teacher.

The problem may be somewhat different for the city teacher from what it is for the country teacher. In the case of the city child with its alert mind and over-wrought nervous system the first requisite is physical contact with nature in her calmer moods. Brick walls, glass, iron and stone and the teeming life hemmed in between them, have dwarfed the mind in some of its powers, as well as accentuated others. The broad horizon, 180° of blue sky, the untainted air, the far expanse of field form the ideal background for the study of the object in its natural environment. So excursions to parks and suburban fields ought to be encouraged whenever practicable.

The country child needs this physical contact not so much as the city child. The mud splash on his face, the stick-tight on his coat speak vigorously of physical contact. What is needed is intellectual contact, to see in the commonplace facts of his life a deeper meaning, a new relationship and hidden beauty. He needs to become acquainted with gems of nature literature with their beautiful expression and portrayal of the facts familiar to him from his own rich experience. Specially does his nature study need to be correlated with his English. He needs to be trained to record accurately and beautifully, what he has seen with an eye long accustomed to clear-seeing. When all this is done, he will not be considered stupid, something will have happened to relieve the dull monotony of daily work. He will appreciate the mysterious chapters of life historic of animals familiar to him. He needs to be helped to nature study literature much more than city children who have access to fine libraries. Herein lies the great value and helpfulness of the Cornell nature study leaflets.

The following principles in regard to methods are so self-evident as only to need statement:

The object selected for study should usually be local so that the child may be brought more nearly into harmony with its environment.

So far as possible he should be encouraged to get the object for himself, be thus compelled to notice it in its natural setting.

Particular care should be exercised to lead the pupil to observe and discover facts for himself, because of the greater interest to him of the fact and because of the training.

The power of reason should be developed by putting observed fact with fact and drawing conclusions, as inferring function from structure or the adaptation of structure to function.

Power of expression should be developed by written exercise and drawings, the latter helping to develop the love of the beautiful.

Finally in dealing with living things such sympathy should be aroused, as to develop kindness and gentleness of heart.

In brief, our method should result in ability to observe accurately, to store the mind with useful facts, to weigh carefully, to feel deeply, to sympathize broadly, and to exert a salutary influence on all the developing powers of the soul.

THE MAKING OF LABORATORY NOTEBOOKS

BY MINNIE L. OVERACKER, SYRACUSE HIGH SCHOOL

The first consideration is the book itself. A well appointed, systematic book is an incentive to a pupil to make his work correspond. While the ideal notebook is probably not yet invented, a usable sort is like this: a stiff cover, preferably black, the student's name in a neat label on the outside, the inside cover provided with a printed slip having spaces for details as to school, science, student, and completion of course, when presented for entrance credits.

The paper to be in loose sheets, half the quantity ruled with the red line at the left when turned, half unruled but of a good quality calendared paper, not the sort known as drawing paper.

The mode of fastening should admit of easy replacing of sheets, yet be sufficiently firm and not of a kind to tear the paper easily.

All our science classes use a uniform notebook, hence the purchase of one cover may serve an economical pupil throughout his high school course.

We like to arrange the exercises in botany in this way: pages having drawings (on one side only, of course) alternating with the accompanying written notes, while the sheets bearing records of experiments, illustrated when possible, are placed in order in the opposite end of the book. An index page at either end shows the contents at a glance.

This arrangement agrees well with the style of book opening at the end instead of at the side, and is also preferable because it takes less room at well populated working tables.

Drawings should be in firm clear outlines—little or no shading—made with sharp, hard pencils; the idea of proportion or degree of magnification in each case indicated. They should be carefully and fully labelled in as neat print as can be achieved, and of course, serially and symmetrically grouped, each subject distinct and given a sufficient number of views to bring out the leading points of structure.

No pupil is allowed to draw an object as it *ought* to be rather than as it *is*, or to draw it today from his memories of yesterday. We try to furnish material that shall be as typical as possible, and require absolutely that all drawings be made from that, with *no copying* from textbooks. Drawing from material under the compound microscope is a tough problem for the average beginner. We let them do their best, then show them a drawing as it should appear, which they often use for correction.

The written notes, which must be in ink, allow a wide range. It has not proven most profitable to say simply, "Describe what you see"; the pupil's mind is thereby set adrift on a shoreless sea from which he usually manages to secure very slight and meaningless treasure-trove. But given a series of pointed questions, that do not answer themselves and which the teacher in charge refuses to answer outright, he must do a little of his own thinking if he writes anything at all.

The method of Agassiz is probably ideal, but hardly practical for a 37 minute period in a crowded high school.

No set of printed laboratory directions has seemed ideal, or even practical; our plan is to make our own as we go along, adapting them to the material in hand, and improving them as light is vouchsafed. Constant effort is made, by asking for comparative study of related structures, to lead the pupil to see the plant world as a whole and to read some meaning in it. It goes without saying that each one's work should be done wholly without conference with his neighbors, though in this point as in many others, constant vigilance is the price of success.

When an exercise is completed, it is handed in, corrected—preferably in red ink—and returned for the pupil's correction. No work is taken home without special permission, which is rarely given.

Our reference books are brought into constant use by frequent directions given in the outlines for laboratory work, sending the pupil to certain authors for light on particular points.

The necessary books are placed on the tables within easy reach. Occasionally a selected list of references on a special topic is posted, and opportunity given for each pupil to register the references read. These side lights all tell of course, in the written notes, as well as in class recitation.

Notebooks are absolutely essential to laboratory work, and laboratory work in botany (either indoors or out) is the sort that really

counts. The pupils often express very decided opinions on this subject; they say "It's the most interesting school work I ever did", "It's the only way to study botany, I think".

Hence the notebook is a pivotal point in all science teaching, and to be really valuable must be honest, thoughtful, painstaking, individual work.

Election of officers for the section then took place, resulting as follows:

Chairman, C. W. Hahn, New York
Secretary, Miss M. L. Overacker, Syracuse

Section C. EARTH SCIENCE

LABORATORY WORK IN PHYSICAL GEOGRAPHY FOR SECONDARY SCHOOLS

BY CLARA B. KIRCHWEY, TEACHERS COLLEGE, COLUMBIA UNIVERSITY

The question is discussed from the standpoint of a college entrance course rather than from that of an elementary study adapted to the earlier years in the high school.

The geography of today or the "new geography" as it is called, burdened by its inheritance from the past and by its own shortcomings, has a reputation difficult to live down—that of being simply an information subject. Till very recently it was primarily what its definition implied—a description of the earth's surface—and though we have passed beyond the letter of this definition the spirit still persistently lingers. Geography is still too widely taught as an information subject. The "six pages a day" method may acquaint a pupil with the words within the covers of his textbook but it will not teach him geography and fortunately will no longer make it possible for him to present himself as a candidate for college entrance in physiography.

The day is long since past when instruction in chemistry, physics, or biology was confined to the printed page. The instructor in these sciences realizes the inadequacy of words in conveying ideas and the need of investigation on the part of the pupil that he may arrive at an understanding of the underlying principles.

This attitude is as essential to progress in geography as it is in biology. Geography too is a science, and must be granted the prerogatives of a science. The subject, correctly handled, has great possibilities for mental discipline; as it is often treated these possibilities are so obscured that they are visible only to those familiar

with the field. We can scarcely wonder that the uninitiated still see in geography a mass of unrelated facts and refuse to give credence to the argument that its disciplinary value is equal to that of the other sciences.

Geography labors under more or less of a disadvantage owing to the fact that its problems are not such as can be analyzed under the microscope or studied in the test tube. We can not bring our material for study within the walls of the schoolroom nor can we go where we will in pursuit of geography. We are therefore forced to content ourselves to some extent at least, with the shadow, the substance being unattainable and with the laboratory rather than the field as our *locus operandi*.

To the laboratory then, and to laboratory work must be intrusted the task of so organizing the subject that the process of accumulating information may be accompanied by true mental discipline. When this is accomplished the less important task—that of establishing the position of geography among the other sciences—will require no advocates. Cause and effect have been operative in the past in determining the standing of geography and may be depended on for the future.

In order to make laboratory work effective an elaborate equipment is not essential but a realization of what may be accomplished by this method is absolutely necessary that its end may not be defeated. That so called " laboratory work " covers a multitude of sins at the present time may be seen by an examination of the laboratory notebooks presented by the candidates for admission to college. Many of these exercises have no place in such a category. Class discussions, bearing no evidence of investigation of any description on the part of the student, are frequently submitted. Exercises, performed by the teacher and copied by the pupils are also presented, apparently with no intention to deceive either on the part of the instructor or the student but rather from a misconception regarding the true meaning of laboratory work.

While the leaders in the field are agreed that there should be laboratory work and that it should be disciplinary in character the greatest diversity of opinion prevails among them regarding the exact nature of this work and the best mode of presentation. This lack of agreement is made evident in the manuals which have been published within the last few years. The various possibilities in regard to the choice of material and in the method of treatment have not been weighed that some common ground might be reached, but each author has emphasized the subject or subjects for which

he has some special preference. The result is a collection of books no one of which should be used as a laboratory guide. Till we have a greater unanimity of opinion among those who would shape the destiny of geography we must not expect systematic, well ordered work on the part of the teacher whose training has not given him a broad outlook over the subject nor can we expect unsystematized work to result in well disciplined minds.

There is some excuse for the fact that the work is not well apportioned among the various departments that constitute physical geography. The subject, embracing "The earth as a globe," "The atmosphere," "The ocean," "The lands" and "The distribution of life" is much too extensive a one to cover from the laboratory standpoint or even with a sufficient amount of emphasis on laboratory work in the period of time usually alloted to it, i. e. one year with three or four periods weekly of perhaps 40 minutes each. This has been attempted for several years the result being work too superficial to be satisfactory to the instructor, not thorough enough to give the student a clear understanding of the subject, and less intensive than he is capable of performing.

In view of these conditions it seems desirable that some common method of elimination be adopted that in time we may arrive at a greater uniformity of treatment and at more satisfactory results. The basis of selection should naturally be that of true educational value primarily. It is therefore necessary that each department of geography be submitted to a critical examination that its relative value from this standpoint may be determined.

The fundamental division of the subject, "The earth as a globe," usually regarded with equal aversion by both instructor and pupils, lends itself admirably to laboratory treatment and so taught it is seen to be so full of vital problems that it is impossible to look on it is a dry subject, or one which is pursued simply to fulfil a requirement. The pupils may regard it as difficult, for each point must be thoroughly grasped before further progress may be made, and before any truth becomes a permanent possession close thinking and frequently a considerable power of visualization are required. This is "hard" in the process but its accomplishment illumines the subject as no amount of class discussion or assigned reading can succeed in doing, and that which would otherwise be true on the authority of the teacher or the text, becomes so to the understanding.

Perhaps the problems of greatest difficulty in the treatment of the earth as a globe are those based on the effects of the revolu-

tion of the earth about the sun. The distribution of light at different seasons and at different latitudes may be memorized but memory work is so transparent that a modification of the usual form of the problem will expose it. If a pupil truly realizes the combined effects of revolution and the inclined axis, that axis may be inclined at any imaginary angle without causing confusion to his mind. If it be grasped, not memorized, that the inclination of the axis determines the width of the zones he will not be at a loss if he be confronted with an earth in which the axis has an inclination of 30° or 40° and the number and width of the various zones are left for him to determine. The varying lengths of day and night at different latitudes, as at the equator, the polar circles and the poles, another problem involving difficulties, when approached in the laboratory from the side of light distribution needs little explanation on the part of the teacher.

These problems may be solved without an expensive laboratory equipment; a season apparatus is of course desirable as the basis for this work. If this can not be secured small globes, together with circles of illumination cut from paper, will be found a good substitute; indeed this should be used even if the more elaborate apparatus be available.

If time permitted it might be shown that it is possible to develop practically this entire subject in the laboratory leaving for the lecture or discussion the summary, amplification and application of the results reached through individual work.

Another department well adapted to laboratory treatment is that of "The atmosphere" and no subject should be more thoroughly studied. The material for this work is always at hand furnishing a field for investigation that can not be surpassed.

In the study of the atmosphere the pupil is largely independent of the teacher except for guidance. A clearer conception of temperature distribution may be gained from the study of isothermal maps than from a lecture. The problem should be formulated with care by the teacher but the solution should be left to the pupil. A similar mode of procedure in regard to the distribution of pressure will show not only the variation of pressure over the world but the reason for that variation with the single exception regarding the cause of low pressure at the poles.

Familiarity with pressure should carry with it ability to cope with the next problem—that of the various wind systems. The pupil should be required to sketch the approximate direction of the winds in the various belts, not alone in the fundamental plane-

tary system but in that of the terrestrial as well, judging of wind direction from his knowledge of the distribution of pressure and the direction of deflection. The results should be verified and corrections made when necessary. The study of the distribution of rainfall should be casual also, the interpretation of the rainfall map depending on the knowledge of wind direction and surface features.

The series of questions which follows indicates more definitely the mode of procedure recommended and the close causal relationship existing among these various topics. The problems are based on climatic maps which may be found in Longmans's new school atlas.

Isotherms for January

1 Record the temperature of the northeastern coast, the western coast and the interior of North America along the parallels of 30, 40, 50, 60 and 66½°.
2 Record the temperature of the eastern coast, the western coast and the interior of Eurasia along the parallels of 40, 50, 60 and 66½°.
3 Compare the temperature of the east and west coastal regions of North America; compare each coast with the interior; compare the east and west coastal regions of Eurasia; compare each with the interior.
4 What is the trend of the isotherms in the interior of these continents? Over the adjacent oceans? Suggest the reason for their irregularity.
5 Where is the coldest land area found? What is its temperature? Where is the warmest land area found? Record its temperature.
6 Compare the trend of the isotherms in the northern and southern hemispheres. Explain.
7 On an outline map of the world indicate the position of the heat equator.

After a similar study of the distribution of temperature over the world for July followed by that of the yearly average, the distribution of pressure is noted.

Isobars for January

1 Locate the equatorial low pressure belt. What is the average temperature of this area? (*See* isothermal map for January.) Where is pressure lowest in the belt? What is the temperature of these areas?

2 Locate the barometric equator. Compare its position with that of the January heat equator.
3 Locate the north tropical belt of high pressure. Describe the temperature of this belt. Where is pressure highest? What is the temperature of this area?
4 Compare the south tropical high pressure belt in extent and continuity with the north tropical. Explain.
5 Describe the pressure about the poles.

After a similar study of the distribution of pressure for July and for the year the pupils should state what relationship they have discovered between temperature and pressure and what exception to this relationship apparently exists. This exception, low pressure at the poles, must be explained as the cause can not be discovered in the laboratory.

The study of pressure is immediately followed by that of the wind systems.

Winds

Planetary. Draw a circle representing the earth. From your knowledge of the average distribution of pressure over the world for the year and of the law of deflection show the approximate direction of the winds.

Verify from consultation of wind chart and correct errors.

Terrestrial. Construct two diagrams showing the effect of the migration of the heat equator on the planetary wind system.

(Diagrams should represent the distribution of winds for January and for July.)

Monsoons. Draw two outline maps of India. In each case represent the mathematical equator. On one map represent the heat equator for January and the consequent distribution of winds for the same month. On the second map represent the heat equator and winds for July. Verify as before and correct errors.

Rainfall

1 Account for the amount of precipitation in regions of greatest and least rainfall.
(Consult map of winds and physical maps as well as rainfall maps.)
2 Compare the extent of desert regions of the eastern and western hemispheres. Explain.

3 Locate the great trade wind deserts.
4 Explain the distribution of rainfall along the western coast of South America.
5 Compare the amount of rainfall east and west of the 100th meridian west of Greenwich. How have life conditions in this section been influenced by the amount of rainfall?
6 State the amount of rainfall in the Great Basin region of the United States. What influence has the light rainfall had on the drainage of this section?

These exercises have been formulated to show the causal relationship existing between temperature and pressure, pressure and winds, winds and rainfall. They are typical however, not only of the work on the atmosphere but also of that of the other departments of the subject, to the extent that they emphasize causes and consequences.

Neither department of geography which has been considered has held as prominent a place in secondary school education as has that of "The lands." We are told that this topic should be emphasized for the land is the home of man and pupils must therefore be made familiar with it.

If this subject be examined from the standpoint of its educational value we may not feel so confident that it is entitled to as much attention as it has received in the past. The field is so broad a one, and is so detailed that to approach it through the laboratory is somewhat appalling unless the time devoted to geography be greatly extended. Moreover, the laboratory seems to fail us here to some extent for, instead of furnishing a field for the interpretation of the most difficult problems these must be reserved for the lecture. The simpler problems, such as the characteristic surface features of a plain, a plateau, a mountain etc. may be studied with profit, also the various stages of development of these land forms. Only a comparatively small portion however, of all that our texts usually require can be taught in the laboratory. For example, the high school pupil is supposed to be familiar not only with the characteristics of plains in general, but with the divisions and subdivisions of plains. He must know not only coastal, alluvial and lake plains but the characteristics of narrow, broad, belted, belted inland and embayed coastal plains. The distinguishing features of all of these various divisions and subdivisions can not be arrived at successfully through the laboratory. It is difficult to see how a pupil could

determine the development and the characteristics of a belted plain from map study. In considering the various classes of mountains similar difficulties are met with. The attempt to analyze the various forms from map study is unsatisfactory for in most instances these forms are so modified that their characteristic features are obscured.

These same conditions exist to a sufficient degree in the various topics that must be considered to render laboratory work as the basis for class work practically impossible. Moreover the amount of detail necessary for the appreciation of many of these subjects is so great that it seems almost necessary for the textbook or for oral instruction to lead rather than for the laboratory. The chief function of laboratory work must therefore be that of illustration wherever it is possible to clarify a subject through the study of maps, models or photographs, or to summarize some portion of class work.

There is a distinct mental relaxation on the part of the pupils when land forms are reached. The weaker student who has found the preceding work beyond him, or practically so, is almost invariably able to cope with this department without great effort. The reason for this is apparent. The subject-matter though voluminous is not difficult. The method of work, enforced by the nature of the subject, demands much less of the pupil, the close, sustained thinking which the previous work has required being no longer necessary, so small a portion of the work being really independent investigation.

In view of the fact that it is an impossibility to cover satisfactorily the entire course of physical geography as outlined for secondary schools by the leaders in the field, it would certainly seem advisable to cut down the requirements on land forms decidedly for the reasons mentioned. If much of this subject were reserved for college and were studied after the student had some knowledge of geology that the relation between structure and surface might be emphasized its disciplinary value would be greatly increased.

It is therefore recommended that secondary work on land forms be confined to the larger features leaving for more advanced study the careful analysis of these various forms, i. e. the various classes of plains and their development should be studied, but not the subdivisions based on structure, as narrow, broad, and belted coastal plains; mountains and their development but not block, folded, domed and massive mountains; plateaus and vol-

canoes together with their development but not the subdivisions of these forms. The two classes of shore lines should be emphasized owing to the strong influence which they exert on the development of human life. Many other topics belonging to the lands should be subjected to the same process of reduction. Rivers, for example, should be studied as young, mature and old while their classification as consequent, subsequent, obsequent, antecedent, superimposed, engrafted, dismembered etc. should be reserved for the college. By thus limiting the field an opportunity for better training would be afforded, for the subjects chosen might then be approached through the laboratory, time for investigation being adequate or approximately so, and the subjects being of a nature to admit of laboratory treatment.

The next department of geography for consideration, "The ocean," has never held an important position in the course from the standpoint of the time devoted to it. Many of the problems to be considered however can with advantage be presented in the laboratory the subject affording therefore an opportunity for some independent work that is valuable. The omission of two or three problems that must be largely descriptive on the part of the instructor, as that of the movement of water particles in a wave, or the detailed and involved explanation of tides, would certainly be no detriment to the course, and would afford an opportunity for the study of topics more valuable to secondary pupils, as those relating to the relationship between ocean temperatures and the movement of ocean waters, the dependence of the direction of ocean currents on the prevailing winds, etc.

The final department left for discussion is that of "The distribution of life." If the work has been well done throughout, life relations have been constantly emphasized. The response of life to its environment, however, whether it be water, land or atmosphere, should be studied when that environment is studied; i. e. when climate is considered its effects on life should be traced; when seashores are considered the influence of shore lines on the development of peoples naturally follows. If life relations be studied in connection with each topic considered throughout the work on "The earth as a globe," "The atmosphere," "The lands" and "The ocean," it will be found unnecessary to treat it as a separate department to be discussed after the completion of the study of the physical environment, as is customary.

Moreover, this department of physical geography is naturally impossible from the standpoint of the laboratory; and while the

argument is not advanced that no mental discipline is involved in the pursuit of such a subject, the claim is made that less discipline results than where independent thought work is absolutely required.

Geography taught by the laboratory method must necessarily be stripped of much that is generally thought to be its most interesting side. If this were true it might still be worth the sacrifice. That the opinion is erroneous will be asserted by those who have investigated and fairly tested this method. The process of solving a problem for which there is a sufficient motive is always interesting to every active minded boy or girl.

The laboratory method, moreover, is disciplinary in its character, affording opportunity for pupils "to proceed by observation and experiment, by guarded hypotheses and careful verification, from the known to the unknown, on the well founded assumption of the uniformity of nature."

A student can not pursue a subject in this manner without gaining a large fund of information which has some value. His chief gain, however, lies in the attitude of mind which must follow the constant weighing of causes and consequences, in the independence which this work promotes and in the power which results from the successful accomplishment of a task and the immediate application of the principle deduced to the interpretation of new problems.

And lastly, geography taught by this method will make for itself a place among those established sciences whose aim is not information primarily but an attitude of mind which the study of a science according to the methods of science alone can give.

PHYSIOGRAPHY IN THE MORRIS HIGH SCHOOL, NEW YORK CITY

BY WILLIAM THOMAS MOREY

The Morris High School was organized in 1897 as the only high school for boys and girls in the old New York city. It is the only high school in that part of the city north of the Harlem river. The department of physiography was organized by Mr Ezra W. Sampson and equipped with the best of the time. The department was always generously dealt with by Dr Edward J. Goodwin, who as principal took more interest in this branch of science than is usual.

When I began work in the department I was not hampered by directions. I was given to understand that inasmuch as those electing it at that time were third year pupils using it to prepare them to enter the normal college, or fourth year pupils going to training school, and that inasmuch as their admission depended on a written examination, it was my duty to prepare them for their examinations.

There being no fixed requirements as to exercises, many experiments were tried at various times. Our problems of excursions, work at the American Museum of Natural History, Aquarium, Weather Bureau etc. are of local interest.

With a few classes efforts have been made to work up the physiography of New York city and vicinity from old and periodical literature, but more of this under:

Supplementary reading. My aim along this line is to have all pupils study as many as possible of the following, as preliminary to, or preparatory for their special topics in the library:

- The Brook and a Handful of Soil. Cornell Nature Study Quarterly, nos. 2 and 5.
- Hudson River and Palisades. In N. Y. News-letter, N. Y. Life Insurance Co.
- Tarr's Physical Geography of New York State.
- New York City and Vicinity. U. S. Geol. Folio 83.
- Powell's Physiographic Processes, Features and Regions of the United States.

Library work. I have had about 150 of our physiography reference library books used by pupils in investigating particular topics. As a result I have a list of some 40 or 50 profitably usable reference books, and another list of topics, which have been investigated. The list of topics with appropriate references have been asked for by the *Journal of Geography* for publication in the early part of 1905.

List of satisfactory reference books[1]

Avebury. Scenery of England; of Switzerland.
Ball. Ice Age.
Bonney. Volcanoes.
Brigham. Geographical Influences.
Bureau of American Republics. Handbooks.
Chamberlain and Salisbury. Geology.

[1]List referred to but not read in meeting.

Croll. Climate and Time.
Crosby. Common Minerals and Rocks.
Dana. Manual of Geology.
Davis. Meteorology.
Diller. Educational Series of Rocks.
Dodge. Readings in Physical Geography.
Dryer. Studies in Indiana Geography.
Geike. Scenery of Scotland.
Geike. Earth Sculpture.
Gratacap. Geology of New York City.
Harrington. About the Weather.
Heilprin. Mt Pelee.
Hickson. Fauna of Deep Sea, Story of Life in Sea.
Hogarth. The Nearer East.
Huxley. Physiography.
Kemp. Handbook of Rocks.
LeConte. Geology.
Mill. International Geography.
Muir. Scientific Study of Scenery.
N. J. Geol. Sur.—An. Rep't. Final reports specially v. 5 [free].
N. Y. Geol. Sur. Rep'ts. Geology, 1842-43.
N. Y. State Mus. Bul. 10, 15, 17, 19, 30, 35, 42, 45, 48, 56, 58 etc.
Partsch. Central Europe.
Physiography of U. S. [Monographs separate].
Romanes. Scientific Evidences of Organic Evolution.
Russell. The Glaciers of North America, The Lakes, The Rivers, The Volcanoes.
Semple. American History and its Geographical Conditions.
Shaler. First Book in Geology, Sea and Land, Nature and Man, etc. specially in U. S. Geol. Sur. An. Rep'ts.
Smithsonian Reports. Separate reprints in pamphlet form.
Suess. Face of the Earth.
Tarr. Physical Geography of New York State.
——Economic Geology.
Tyndall. Forms of Water; Glaciers of Alps; Hours of Exercise.
U. S. Geol. Sur. Annual reports and selected monographs and bulletins [free]. For lists and bibliography order bulletins 127, 177, and 188.
Wallace. Island Life; Tropical Nature.
Ward. Exercises in Meteorology.
Whitbeck. Geography of New York State.

Winchell. World Life.
Woodworth. Pleistocene Geology of Nassau Co. and Borough of Queens. N. Y. State Mus. Bul. 48. Several copies.
Wright. Ice Age of North America.

Visual instruction. We are just now getting into the use of our rich store of lantern slides. The basis of our collection is the 126 slides selected for the Cambridge [Mass.] schools by Prof. W. M. Davis. whose textbook we use. To this about 100 were added, while Mr Arthur T. Seymour was in our school, from the Cornell slides of Prof. R. S. Tarr. Within the last year 325 colored slides were selected from the 30 lists and over 2000 slides of the world famous "Bickmore slides" for the illustrated lectures delivered by Prof. Albert S. Bickmore at the Museum of Natural History under the auspices of the State Department of Public Instruction. Under proper conditions the slides and a lantern can be obtained temporarily from the same department. This is a matter that should be investigated by every physiography teacher in the public schools of the Empire State.

Syllabus. As a result of the urging of the teachers of physiography in the New York city high schools the Board of Superintendents adopted last spring a syllabus which meets the College Entrance Examination Board requirements as to 40 counts for individual laboratory and field work, inserts a larger list from which to choose exercises, and gives as is necessary for our 10 city high schools a more detailed outline. This syllabus states that the pupils preparation should include:

1 The study of a standard textbook, for the purpose of gaining a knowledge of the essential principles and facts of physical geography.
2 Individual laboratory and field work to the amount of at least 40 counts, selected from a list not essentially different from the accompanying list.
3 Instruction by lecture table demonstartions, and lectures illustrated by stereopticon views.
4 Collection and study of pictures illustrating the various phases of the subject.

The notebook will count for 20% of the grade in physiography.

Place in course of study. Formerly physiography was required in third year; now it is an elective in the fourth year. It has four periods a week allotted to it. The high school principals to whom the syllabus was submitted before its adoption, struck out the suggestion that it have three prepared periods and an un-

prepared double laboratory period per week, on the ground that the course of study gave it but four periods a week. In our school we have tried to live up to the letter of the course of study.

Exercises. At the request of Dr Goodwin, I prepared, and submitted to him Dec. 18, 1901 a list of 111 exercises in physiography, of which about 51 had been done wholly or in part by the pupils. This list was revised in fall of 1903 and reduced to some 55 laboratory exercises and 20 field work exercises. I shall describe some that, so far as I know, are elsewhere not done or are done differently.

Inasmuch as we get about one laboratory period a week, in place of the double period with three prepared lessons a week, obtaining in at least one of our city high schools, the exercises in the Morris have differed in character somewhat from those where it is not so necessary to finish, or to complete an integral part of, an exercise in one period, say of 43 minutes. Some of our exercises are planned to be divisible at several places, as in the study of contours.

To learn to make and to use contour topographic maps.

a To make contours of a mountain-shaped stone, by pouring in successively say ⅓ inch of water.

b To determine hights on contour maps, specially of places not on contours.

c To draw contours when hights are plotted.

d To make vertical sections from contour maps (*a*) above have pupil draw side view to exact scale, for use as a test in *d*.

e To make contours from vertical sections, e. g. from views of Vesuvius from n., n. w., w., and s. w.

It is not pretended that all of the above or any part of it must necessarily be done to understand and to use contour maps. Some pupils walk before they creep.

Maps. While I admit that map-making may easily be carried to excess, and that it is not the best method of developing power, I do believe that three maps I have had practically every one of my pupils make are worthy of credit towards the 40 counts—(1) Physiographic regions of the United States, after Powell; (2) Physiographic regions of New York State after Tarr; (3) Physiographic regions of our vicinity, New York city. Many of my pupils have made maps of river partings and systems of the United States and of New York.

Effects of rotation on currents (Ferrel's Law) taught by first having pupil at his home by means of specific directions pour water

on a rotating umbrella, noting, drawing, and writing up the effects. Afterwards in the laboratory, water may be poured on the rotating slated globe.

The length of the longest day, shortest day, and time of sunrise therewith are worked out by means of protractor, ruler and compass.

Length of a degree of longitude at any latitude by means of compass, ruler, scale and protractor.

Study of the moon and its phases. Record of observations with date, relative positions, and shape, and plotting of various observations.

Tides for a month. Plotted, studied, and variations explained, referred to.

How a vessel enters New York harbor, references given.

Snow and snow drifts. Sample of work done by best pupil on drifts in school yard, with explanations, passed around.

Scale of hardness. A convenient way of performing and recording this exercise.

Geyser action may be illustrated by using a long piece of gas pipe etc.

Brief explanations without the sketches would, for most of the preceding, prove unsatisfactory and detailed explanations would prolong this article unduly. The author hopes to publish soon and in shape to be put into the hands of the pupil, detailed directions for all of his laboratory and field work in physiography.

PHYSIOGRAPHY A LABORATORY SCIENCE

BY W. W. CLENDENIN, WADLEIGH HIGH SCHOOL, NEW YORK CITY

[Abstract]

All interested in the better teaching of physiography realize the necessity for making it a laboratory science. There is no disposition among teachers of the other physical and the biologic sciences to return to the nonlaboratory method.

The obstacles encountered by the other sciences in passing to the laboratory basis present themselves in the way of this latest candidate for better recognition. Some of these are the indisposition to make radical changes, both among those responsible for curricula and those teachers of the subject not specially trained in it; the added expense of laboratory equipment; the difficulty of arranging a program to include laboratory work, and the lack of suitably trained teachers.

But as the fight was won for the other sciences, so may it be won for physiography, if those engaged in it are persistent in their demands. A most valuable aid will be the acceptance by colleges of physiography, when properly taught in a laboratory way, as an entrance requirement.

A few peculiar hindrances to putting physiography on a laboratory basis need consideration.

1 Lack of agreement as to what a course in physiography shall embrace. The American plan of treating physiography as an earth science seems best. Though not properly considered a distinct science, yet a very definite composite of other sciences, specially astronomy, meteorology, oceanography, and physical and dynamic geology, each contributing a necessary part to the understanding of the development of the earth and its relation to life.

Only so much of the biologic and other physical sciences should be included as is necessary to make this development and relation clear.

More consideration should be given the study of the air than is given in any of our texts on physiography. No other part of the subject can be so universally and uniformly presented from the standpoint of everyday, practical interest, and with a larger basis of observation and experience on the part of the scholar.

2 Uncertainty as to the position of physiography in the secondary school course. Because it appeals so strongly to the common, everyday experiences of every scholar many claim for it a place in the first two years of the course, before the study of physics and chemistry. But inasmuch as it must suffice for most scholars for their entire training in earth science, and since in its laboratory phase it deals so largely with questions of a quantitative character, it would seem preferable to have it come in the last two years, if possible after physics and chemistry.

3 The difficulty of fitting laboratory and field work into program. As a rule, one double laboratory period is to be preferred to two single periods, and when possible this should be placed at the end of the school day to facilitate field work. The double period affords better opportunity for serious consideration and interpretation of results, thus robbing the laboratory work of its too mechanical character.

In order to secure satisfactory results from field work, every scholar should be fully instructed beforehand as to what he is expected to look for, and should be required to make an early report

on his field excursion. Without the direction many important things will pass unobserved, and without the report the excursion is apt to degenerate into a holiday picnic.

Occasional full day, voluntary excursions on other than school days, are pleasant and profitable, chiefly for the opportunity they afford of broadening the scholar's horizon, and serving as appetizers for the work of the subject.

The character of the field work must be determined by the environment of the school, though out-of-door exercises on the air may be undertaken anywhere.

4 The lack of a sufficient laboratory guide. This is at present a serious handicap; but good guides will be forthcoming as soon as the demand for them really exists.

All teachers of physiography are urged to use their best efforts to secure for physiography an equal place among the secondary school sciences; and no more effective means are at hand than to make it a laboratory science.

Two laboratory exercises, "Making a modified Mercator's map" and "The determination of the length of the day by use of a globe and daylight circle", were explained.

SOME CONTRIBUTIONS TO LABORATORY PHYSIOGRAPHY

BY WILLIAM F. LANGWORTHY, COLGATE ACADEMY, HAMILTON

Such a conference of teachers as this here assembled seems timely. The educational world has been slow in recognizing the importance and practicability of laboratory work in physiography. At last the time seems at hand for its general introduction. Many and perhaps most educators will agree that as much attention should be given to laboratory work in this subject as in physics or chemistry.

I have been asked to describe two or three exercises which I have planned or have found specially valuable with my classes. I do not feel that I could do this helpfully without some general suggestions as to laboratory work.

In the first place, it seems wisest to use both laboratory and field exercises in connection with a good textbook. The observations in the field make clear many facts otherwise only indistinctly understood, and develop an intelligent interest in nature. Work in the field should proceed side by side with laboratory work.

The laboratory exercises should be distributed as generally as possible over the different parts of the subject. Equipment with

topographic maps and all that is necessary to carry on work with them is very easily and economically provided. Probably this fact, as well as the importance of the work itself, will make such work very prominent in any laboratory course. In our own State these maps are coming from the survey with great rapidity and make work on the home map possible in an increasingly large number of localities. I find it a good plan to begin work on maps with a comparison of different ways of showing relief and attempt to bring out as clearly as possible the advantages of the contour map. With the topographic map of our locality before the class, definite questions are put as to scale, contour interval, features shown by brown, black, and blue ink etc. This is followed by a change of a part of the map to a hachure map. Students find this hard because of a failure to understand hachure maps. One or two profiles are then constructed across our village, taking pains not to exaggerate the vertical scale too much. These profiles cover territory which students go over in the field with map in hand. Various features revealed by profile are then discussed. For instance, the student's attention is called to the fact that the valley in which Hamilton is situated is an open mature valley. Our profile, however, crosses two branch valleys which are young and one which is fairly well developed. Another feature emphasized is the rounded summits of the hills; with causes. Other exercises on the home map follow till the student becomes familiar with its details as seen in field and represented on map. The student is then ready for the study of other maps, and this work has been made more easy and tangible.

So much improvement has been made in training pupils in drawing and map-making that we find it possible to require much work of this kind. I prefer it to using outline maps already prepared. Of course, these maps lack accuracy of detail as compared with printed outline maps and consume much time in construction, but the knowledge of one doing the work seems to be increased much faster.

The following are some of the exercises which I give my classes after they are fairly well advanced. Each of these exercises requires two 50 minute periods for its completion. The first is an exercise on the "River basins and divides of New York State."

1 Construct outline map of New York State and trace divide separating St Lawrence, Hudson, Delaware, Susquehanna, and Mississippi drainage.

2 With crayons color St Lawrence basin blue, Hudson red, Delaware blue, Susquehanna yellow and Mississippi red.

3 *a* What is the highest elevation in the State?
b Is New York a high upland?
c Is the fact of the wide dispersion of its waters unusual?
4 *a* Near what divide do we live?
b What is its elevation in our own valley?
5 *a* What is the average slope from source of Oriskany creek to where it empties into the Mohawk?
b For whole distance from Bounkville to tide water?
6 *a* What is the average grade in our valley from divide to Binghamton?
b From divide to Chesapeake bay?
7 *a* What is the result of this condition?
b Do you see any evidence of this on Morrisville sheet?

The next exercise deals with the "Temperature and precipitation of New York State."

1 From charts in annual reports of New York State Weather Bureau and the New York section of the climate and crop service of the Weather Bureau for past 10 years determine average annual temperature and rainfall at Hamilton. Arrange data in table.

2 Why do isotherms bend to the north in the Hudson valley?

3 How much lower is the average annual temperature in the Adirondacks than in the St Lawrence valley? Account for this.

4 Where is the highest average temperature in the State found? Explain.

5 How does the average rainfall in the Adirondacks compare with that at the east end of Lake Ontario? Explain.

6 In what parts of the State is the heaviest precipitation found? Explain.

The last exercise is a "Study of the Cucamonga, Cal. map."

1 Locate Cucamonga map on general map of California.
2 How many square miles of land are covered by it?
3 What is the contour interval?
4 *a* What mountains lie to the north?
b What is their elevation and character?
5 *a* What mountains lie to the south?
b What is their elevation?
6 What is the length, width and elevation of this valley?
7 *a* What is the average slope a mile from Cucamonga peak south for four miles?
b What is the slope from foot of mountains south to Cucamonga?

8 Make profile from Cucamonga peak to Cucamonga.
9 What do you know about the rainfall of this region?
10 How does this find expression in streams from mountains?
11 *a* Are most streams lowering their beds?
b How about these?
12 *a* What relation to the mouths of the gorges do the contours have?
b How do you explain it?
c What do you call such topographic forms?
d Notice distributaries.
13 *a* What do you know about the climate of this region?
b What alone is needed to make it exceedingly fruitful?
c What measures are taken to obtain water for irrigation?
d What has become the chief industry?
e How valuable is the land?
14 Recapitulate the conditions which make this region specially favorable for the formation of alluvial fans and cones.

In conclusion I wish to say that in secondary schools the laboratory work in physical geography should be very simple and elementary. We often underestimate the difficulties of beginners. Our work should be definite. Otherwise discouragement is sure to result. Do not take a pupil into the laboratory, place a map before him and ask him to explain what topographic features are shown. Skilful questioning will bring him to the correct understanding of the problem presented. To illustrate what I mean, be careful to insure a good understanding of the flood plain features of the Mohawk at Utica and the Mississippi at Donaldsonville, Louisiana, before you expect him without the aid of definite questions, to discuss those of the Missouri at Marshall, Mo. Do not undertake map excursions, so called, till the student is well advanced. There is an exactness of relations between cause and effect in chemistry and physics which is to some extent lacking, or perhaps imperfectly understood, in physical geography, and we need to guard against bewilderment by using special care to guide our pupils by a large number of pointed questions. If this is done, I am sure we will be pleased with their development.

THE RELATION OF GEOGRAPHY TO HISTORY

BY A. W. SKINNER, ONEIDA

In considering the subject assigned me I have been in doubt whether your chairman desired a discussion on its formal aspects, physiographic conditions and changes which have determined his-

toric growth, causes and results with which from a scientific standpoint you are familiar; or whether we should consider how the rich stores of knowledge which geology and its kindred subject, physical geography, may be used to serve the boys and girls whom we teach. I am more inclined toward the latter view particularly in its relation to our grammar and primary schools, for the work of a school superintendent brings him into more intimate relation to and a fuller appreciation of the importance of elementary education. When we consider that for the great majority of our children school training and school opportunities cease when they reach the age of 14 we can appreciate the vital importance of so enriching the elementary course of study as to give them some glimpse of the larger things of life, some fitting for more than the bread and butter side of existence, some appreciation of the beauties of literature, some love for reading, some knowledge of the history of their own country. If we can show them these things we have given them the essential power of self-enjoyment and self-control. When I see men and women who have no source of mental pleasure other than that found in a cursory examination of the daily paper; who when left to their own resources are utterly incapable of self-entertainment, I feel a sincere pity for them mingled with resentment that the paucity of their early training has left them so mentally helpless.

If therefore I am able to say something which shall present to you a new view of your opportunities and responsibilities in this phase of the child's training, I shall feel amply repaid. In no way can the ethical and cultural side of education be better accomplished than through the correlative study of language, history and geography. The three are so closely interwoven that the skilful teacher would no more think of teaching one without showing its relation to the others than he would try to teach algebra without referring to the essential facts of arithmetic. Even the unskilful or inefficient teacher, no matter how aimlessly or indifferently he may rattle the dry bones of fact, can not avoid clothing them somewhat with the flesh and blood realities of life.

That geography makes history and that literature is largely an expression of the lives of a people are truisms needing no proof. Conversely, it is often true that a people in the making of their history may change, modify or bring to the surface dormant physiographic resources. There is no better illustration of this in our own history than in the way the Mormon exodus builded an empire out of the desert wastes of Utah. To assert, however, that

the geography of a country wholly determines the history of that country is to err on the side of extravagance. Who can say that the history of Virginia would not have been widely different had the Puritans, picked men of the old world civilization, settled along the fertile banks of the James and York instead of on the rocky shores of New England. It is nearer the truth to say that climatic conditions and environment plus character are the determining factors, vastly outmeasuring the other factors which go toward the making of a nation. The fertile valleys of the Tigris and Euphrates, the Nile with its yearly deposit of rich alluvial soil, were the homes of great nations whose sustenance came from the soil. The Greeks, on the other hand, with their little kingdoms separated by rugged mountain ranges, isolated by natural boundaries from each other, but with deeply indented coast lines, turned toward the sea, and found the source of their wealth and prosperity in commercial relations with the islands of the Aegean and the popular shores of the eastern Mediterranean. But there is no better proof of the influence of geographic conditions in the development of a nation than may be found in the history of our mother country. The English channel is the most important feature of English history. Seagirt as she is, the little island has been free from invasion for a thousand years, and her people have been able, undisturbed, to work out the problems of self-government and commercial supremacy. With her resources of mine and forest and soil, with her tidal rivers and great harbors and her commercial relations with colonial dependencies, she has grown naturally to foremost rank among world nations. Holland vied with her for a time but Holland had no such natural barriers to protect her from the encroachments of surrounding nations. Spain, on the other hand, isolated by the Pyrenees, with the possibility if not the power of acquiring Portugal, had an opportunity for self-development not unlike that of England. Here, however, the elements of character governed. The Castilians lacking the vitality and energy of the English further enfeebled by an unholy wealth wrung from Mexico and Peru, have gradually let slip from their nerveless grasp their rich colonies and have been content to see their nation become one of minor importance in shaping the destinies of the world. How, then, can one teach the geography of these countries without emphasizing again and again their history and the moral lessons which that history shows? History is an interpretation of past life as a guide for the future. National calamities must inevitably follow national sins, and I firmly believe

that Spain's present pitiable condition is due, in a measure, to criminal mal-administration of her colonial possessions. Turning now to a consideration of certain geographic features of our own country, we may see clearly that the history of the United States was largely written before the white man reached its shores. The great mountain barrier of the Appalachian system towering from three to seven thousand feet above the sea, limited for nearly two centuries the English colonists to the Atlantic slope. The great gap in it known as the Hudson and Mohawk valley was then and is increasingly so today, the only easy avenue of approach to the natural resources of the West. The Mississippi valley was fore-ordained of God to be the granary of a great people and its riches are being poured in a ceaseless stream through this channel, and where steam has surmounted natural barriers, through other channels, into the export cities of our Atlantic seaboard.

Physiographic conditions in America, as elsewhere, have influenced the growth of cities. Water power, often in conjunction with tidal rivers, good harbors, natural centers of distribution, have built up our great towns. Perhaps New York city is the best illustration of this. Nowhere else is there such profusion of natural advantages coupled with the product of human ambition. With its unrivalled combination of harborage and lines of internal communication, standing at the threshold of a continent, with its coastal trade protected, with materials for its massive buildings, the clays of the Hudson, the brown stone of the Connecticut valley and the granites of New England accessible, and with the coal fields of Pennsylvania at its door it could not fail to be a great center of population. As London has had its most marvelous growth since the acquisition of India and the building of the Suez canal so we may prophesy that with the Isthmian canal and the growth of our eastern trade New York will become the first city of the world. The Empire State also is a record of historic development along geographic lines.

Before the coming of the white man the Iroquois in their "Long House" established the most powerful confederacy of aboriginal America. They were quick to seize what Fiske calls the most commanding military position in eastern North America and through the avenues of the Champlain and Hudson on the east, the Oswego, Genesee and St Lawrence on the north, the Delaware, Susquehanna, Alleghany and Ohio on the south and the Great Lakes on the west, they levied tribute from the Atlantic to the Mississippi. In after days the French and Iroquois fought here for the possession of an empire.

There are no fairer or braver pages in our history than those which record the heroic self-sacrifice and holy enthusiasm which the Jesuit missionaries exhibited when they sought to establish the cross of Christ and the Lilies of France among the Iroquois of Central New York. Fathers Jogues and LeMoyne lived for some time among the Indians on the shores of Onondaga lake, and this fall, the citizens of Pompey, a little hill top village, a transplanted relic of New England, overlooking the city of Syracuse, commemorated the 300th anniversary of the establishment of a Jesuit mission there. When the tide of immigration swept through the State, it followed old Indian trails and water courses. Villages grew into prosperous cities where water power was abundant, or where a break in the lines of traffic necessitated a "carry" and a consequent disembarkment of cargoes. One can trace the successive waves of immigration in this State by the names of places along the line of the New York Central Railroad. Amsterdam, Fonda, Herkimer, Sprakers, typify the invasion of the Dutch and the Palatines; Whitestown, Rochester and Auburn, the New Englanders, who found broad acres of fertile fields awaiting them in central New York. Here too, men who knew and loved their Latin, scattered with a lavish hand whole pages of a Latin gazeteer and we have Rome, Utica and Syracuse. It is fortunate also that we have preserved so many of the melodious Indian names, as Chittenango, Canastota, Oneida, Onondaga and Oswego. There is no more convincing proof of the importance of physiographic conditions, varied productiveness of soil and cheap transportation than the fact that four fifths of the population and nine tenths of the wealth of the Empire State is embraced within the counties bordering the Hudson and the Erie canal. It is an abortive teaching which does not emphasize these and many other kindred facts in the geography lessons on New York. Passing to a broader view: if the eastern mountain wall limited the English for years to a narrow strip of land to the eastward, it also enabled the French to explore and in a measure, to establish themselves along the great lakes and valleys to the westward. These hardy voyageurs, these intrepid knights of the forest, with prophetic visions saw and seized on strategic points for peace and for war and as a result of their foresight and judgment we have Quebec, Niagara, Detroit, St Louis and New Orleans. The geography of these localities would be incomplete without the stirring tales of Champlain, Marquette, Joliet and La Salle. Thus we may weave together history and geography, biography and romance in such a way that each shall explain and illuminate the other.

What does such association of related subjects mean for the child? Clearly some appreciation of the causes which lead to the industrial and social development of a great people, some love for the history of his country, some power to interpret the train of events. Such fitting, such education, furnishes the well informed mind, signifies the cultured man or woman, builds a better and more permanent citizenship.

GEOGRAPHY MATERIALS AT HAND

BY PRIN. ANNA J. STONE, JARVIS ST. SCHOOL, BINGHAMTON

The chairman of the earth science section asked me to say something at this meeting about the use of pictures in geography work for the lower grades. His letter reached me while I was cleaning the back yard of summer debris. On one side stood a couple of shocks of corn stalks with a few ears of late corn. Over there were the pumpkin vines, drooping with the early frost, and the big yellow pumpkins suggesting the toothsome pies of Yankee origin.

There were the sweet pea vines to be torn from their wire frames and thrown over the tulip bed. There were the dried bean vines with the bursting pods of speckled beans for succotash. Over in the corner were a dozen heads of cabbage, a treat for the buff wyandottes that would repay in eggs and fried chicken. On the south side of the house, lying in the warm sunshine, were the flower beds, where asters, geraniums and lady sultanas were to be pulled from the bosom of mother earth and spread over the new chrysanthemum plants to help support the weight of the fertilizer, their winter overcoat, which would soon be scattered about the roots of the trees and bushes. A few belated black and brown caterpillars crawled away to some sheltered spot to spend the cold months in solitary confinement, awaiting the time when they were to burst forth from the cocoons at their annual spring opening. The apples and late pears were to be harvested, the squash and onions stored away in a place of correct temperature, and the grass to be raked clear of barrels and barrels of dead leaves before the snow and ice came to mat them in a sodden mass.

Overhead the hazy clouds floated beneath a sea of clear blue sky, while a few birds held a noisy conference on the grape arbor and crimson rambler trellis, probably discussing the cat and dog that seemed to be in their way, for as soon as these quadruped marauders left for their own homes, the birds with their keen

instinct for food, swooped down on the cement driveway in front of the barn, where the horse had partaken of his midday meal of oats and hay.

In the near distance I could see the gleam of the winding river, and over beyond the hills, with patches of woods and meadows, an indistinct outline in the smoky atmosphere.

The sun dropped down in the west while my shadow lengthened toward the east, and then over the hill, accompanied by the evening star appeared the new moon.

What are pictures compared to all this wealth of material lying right about us, never twice alike, always changing, always pleasing, always surprising to him who can see the hand of God in the earth.

I have mentioned about fifty materials, any one of which is so common we scarcely give it a thought.

All that is needed is an earnest teacher to make a wise selection of her topic and to present it without squeezing out all the juice of interest the youngsters might get for themselves.

Other things being equal, one good teacher with a real love of nature is worth more in a school than a whole faculty than can interpret and quote the latest psychology, but can not see "sermons in stones."

This love of nature is highly contagious to those who are exposed. It takes but a few eager children to introduce the fever into a school and it spreads like chicken pox or mumps.

Last fall some fifth grade children went hunting for cocoons to store away with their other treasures. A kindergarten boy "tagged" along and when he came back he had a caterpillar crushed in his chubby little hand. "Here, teacher," he said, "is a dafferbillar. Make me a buckerfly."

Now, many teachers have no back yard, or front yard either. For them are the atmospheric agents. The weathering of all things about us is most interesting.

The path of the earth, the position of the sun in the morning and evening, the length and direction of shadows can be understood by the smallest child in school.

Too much physical geography is often attempted in the lower grades. The boy who said, "The change of seasons is caused by the bottom of the ocean rising to the top of the water and changing the wind, and when the wind gets changed the seasons have to change," understood the situation quite as well as the girl who said, "The paralysis of the earth's axis, changes the seasons."

Then there are such opportunities for point of contact in home industries.

I do not approve of taking classes to factories and shops. The workmen object and the children do not understand the working of the machines, except that the wheels go round.

Most manufacturers will loan products in the various stages of given in a schoolroom, and the dangers greatly diminished.

The furniture in the schoolroom, the clothes on the child's back, the shoes on his feet, the food he eats are all fruitful subjects.

These lessons can be made the basis of composition and letter-writing. A make-believe letter lacks the spice of the real thing. One of the most successful lessons in letter-writing was an exchange of letters between a certain New York city school and our semi-rural one.

Who would like to exchange a set of letters in grades two to seven, inclusive, with the pupils in Jarvis Street School, Binghamton N. Y.?

A general discussion followed this paper in which nearly everyone present took part.

New York State Science Teachers Association

Syracuse N. Y., Dec. 28, 1904

The earth science section of the New York State Science Teachers Association at its ninth annual meeting at Syracuse N. Y., Dec. 28, 1904, resolved, That this section recommends to the proper State authority that physiography be put in the last year of the high school course, and that the requirements as to syllabus and exercises be not essentially different from those of the College Entrance Examination Board.

AMOS W. FARNHAM
Chairman, Earth science section

ERNEST R. VON NARDROFF
President, New York State Science Teachers Association

Section D. MATHEMATICS

SUGGESTIONS ON THE TEACHING OF ELEMENTARY ALGEBRA

BY F. L. LAMSON, UNIVERSITY OF ROCHESTER

I have but two points to bring out in this discussion. First, in the teaching of elementary algebra the teacher should have with each class some one definite purpose constantly in mind. Second,

the requirements in advanced algebra should include a smaller number of topics and they should be more explicitly outlined. Before a teacher can profitably fix on a purpose that will produce marked results he must be familiar enough with the beauty and the efficiency of the symbolism of the science and have sufficient grasp of its truth to make him fearless and free. Such familiarity and grasp can be had only by the same method as in the case of good literature. The student of Latin does not confine himself to the study of Latin texts, but studies carefully Roman history and life, and the histories of peoples that exerted an influence on and were influenced by Roman life. It is only by putting the light of such research on the Latin literature that he can comprehend and appreciate it. It is precisely so with the student and teacher of algebra. He must not confine himself to the study of elementary texts. I can see little advantage in having several texts of elementary algebra in one's library; but he must make a close study of the history of mathematics, the vocabulary of the science, and constantly review the high school algebra in the light of his advanced mathematical training, and read carefully and critically the best literature on the subject of the teaching of elementary mathematics. A reasonable study of the history of mathematics will give results that may be set down as follows:

1 Addition, multiplication, and involution are direct and progressively related operations. That is, he will teach these operations not as special and distinct, but as progressively related.

2 Subtraction, division, and evolution are the corresponding inverse operations.

3 Imaginary, irrational, rational-fractional, and negative quantities have a common mode of origin; namely, by means of inverse operations in which their introduction is rendered necessary by the further progress of the science.

4 "Every time a newly introduced concept depends upon operations previously employed the propositions holding for these operations are assumed to be valid still when they are applied to the new concept." As a result, he will add interest in the treatment of the zero, fractional and negative exponents, if, governed by the principle just stated, he teaches the pupil to interpret these new conditions in such a way as to make their meaning consistent with the principles and operations already established.

5 The growth of algebra has been divided into three periods. The rhetorical, that in which the equation is written out in words; the syncopated, that in which the words are abbreviated; the symbolic, or the modern algebra.

6 A general idea of the trend of the science, and a fund of information that can be used with classes to create interest.

The study of the vocabulary and symbols of the science will give some of the following results:

1 An understanding that will free the teacher from the rigid adherence to textbook definitions. The need for such freedom is indicated by the following illustration: "A coefficient is a number placed before another number to show how many times it is to be taken." The teacher who follows the word from its first association with the science will know that the technical meaning that it has assumed is expressed by the term "cofactor" and that, therefore, any factor or combination of factors of an algebraic expression is the "coefficient" of the rest of the product.

2 An understanding of the exact and limited meanings of symbols used. In visiting one class I noticed and noted the following:

Let x = A's money
Let x = the leaps taken by the hound
Let x = the distance up the hill
Let x = the larger pipe

Such absurdities indicate not a carelessness in teaching, but a failure on the part of the teacher to understand clearly the significance of the symbols used.

3 An appreciation of the value of the use of symbols that will result in a more intelligent and extended application of them, such as (x), and this idea applied to the typical formulas such as $(x \pm y)^2 =$, $(x \pm y)^3$, $ax^2 + bx + c$, $(x^3 \pm y^3)$, $(x+y)(x-y)$. Students soon see the advantage in writing and discussing such algebraic expressions as $x^5+6^4x-5^3x \cdot 3^2x^2+2x+1$ in representing it by a single symbol $f(y)$. The early study of the remainder theorem will help the students in their appreciation of this extended symbolism.

The carrying of the idea of symbolism to the typical parts suggested above, simplifies factoring to five or six general cases, and the first thing in factoring a given algebraic expression will be to translate it in terms of some one of the symbol forms.

The review of elementary algebra in the light of the training in higher mathematics, such as analytic geometry, calculus, and theory of equations, will free the teacher from rigid adherence to the set treatment given in any single text. He will see the great advantage in the use of the graph in the treatment of simultaneous equations. He will be able to decide for himself where to draw the line in factorable expressions—whether x—y can be factored, whether or not the highest common divisor of two or more algebraic

expressions is the product of all their common prime factors. That is, he will be able to reconcile the following statement in Milne's *Academic Algebra:* "The highest common divisor in algebra corresponds to the greatest common divisor in arithmetic," with Beaman & Smith's statement that the arithmetic greatest common divisor must not be confounded with the algebraic highest common divisor. Whether or not an axiom is a self-evident truth, or whether there are exceptions to some of the truths, long passed as self-evident, such as "equals divided by equals are equals," "like roots of equal quantities are equal;" whether or not it is best to introduce the quadratic equation with factoring, or to follow the colleges and College Entrance Examination Board in their "to quadratics" and "through quadratics." In fact, he will understand the bearing one part of the subject has on the other.

To this preparation should be added the ideas that come from a careful and critical reading of the literature on the general subject of the teaching of elementary mathematics, of which there is beginning to be much that is suggestive and extremely helpful and inspiring. The teachers of elementary mathematics should seek to provide the school libraries with the best of such literature. In visiting four high school libraries I found that the number of books and publications available for use by the department of mathematics was two; one being Davis's *Elementary Arithmetic,* and the other Brooks's *Plane Geometry.*

I find also that many teachers of mathematics are not aware of the fact that much valuable literature on the teaching of elementary mathematics has appeared during the past five years. They are totally ignorant of the present existence of the two leading theories of the teaching of elementary mathematics.

Now, with his study of the history of the science, the vocabulary of the science, the review as suggested above and familiar with the experiences and thought of the best teachers he will go to his teaching equipped to form some definite purpose and capable of accomplishing it. One purpose that might be suggested as profitable and practicable is the training of the student through algebra to give an intelligent and exact expression of his thought in terms of the science. To do this he must be taught to observe and fix on the salient points of each lesson or topic so that he can intelligently interpret and discuss and explain them. He must be taught to take up each new section of the subject with the understanding that before he leaves it he will be required to show its relation to the parts of the science he has already mastered.

The question of the method of getting these results will then largely take care of itself, for I am convinced that before new and improved methods of teaching can make very great progress, the main body of the teachers of mathematics must wake up to the necessity of making definite preparation for their work. In concluding this part of my discussion then, I hold that a normal school training can not, a college training does not, and experience will not, of itself make a teacher of secondary mathematics, but that the best teachers are those that have had the advantages of the study of the advanced mathematics, supplemented as outlined above.

With reference to my second point, the present Regents syllabus (New York) requires for elementary algebra nine distinct topics covering in the general textbooks about 275 pages. The completion of this course is counted by the Regents one year's work. In advanced algebra 17 topics are placed in the syllabus, the treatment of which covers in the average texts about 200 pages. The completion of this course is counted by the Regents as one-half year's work. These two requirements seem to me out of proportion, and in view of my experience with classes attempting to cover the work laid out in the syllabus in advanced algebra, I believe that there would be great advantage if the Regents would outline a course including a smaller number of topics, giving with each a complete outline. For the purpose of discussion, I suggest the following course:

1 Theory of the quadratic equation
2 Ratio and proportion (and variation)
3 Arithmetical and geometric progressions
4 Permutations and combinations
5 Binomial theorem for all exponents with proof for positive exponents
6 Theorem of undetermined coefficients and its simple applications
7 Logarithms
8 Complex numbers with graphic representation of sums and differences

This eliminates from the course as laid down radical quantities, inequalities, interpretation of the forms, continued fractions, summation of infinite series.

In answer to questions relating to the arrangement of the course the following answer is given.

My experience as teacher of elementary mathematics has led me to feel that there would be a great advantage if, instead of a high school curriculum calling for one year of elementary algebra, one

year of plane geometry, one half year of advanced algebra, one half year of solid geometry, one half year of plane and spheric trigonometry, we could have a course in elementary mathematics with three or four hours, weekly throughout the four years, with a textbook of first year mathematics, second year mathematics, third year mathematics, and fourth year mathematics, in which the one to one correspondence, the interrelation, or better perhaps, the unity of the subjects taught in a high school course would be impressed on the pupils.

THE LABORATORY METHOD OF TEACHING MATHEMATICS

BY W. BETZ, EAST HIGH SCHOOL, ROCHESTER

When, at the request of the secretary of this section, I tried to sum up my casual remarks, and to add a few explanatory statements of a general character, I found myself in an unenviable dilemma. No single comprehensive treatise on the subject, to which I might refer, has appeared in the English language. On the other hand, the periodical and pamphlet literature, on this and closely related topics, has become so extensive in the short interval of a few years, that it seems very difficult to state briefly the origin, content, and significance of this departure from the traditional path in the mathematics of the secondary schools.

To understand the new movement completely, one must be an actively interested student of modern educational developments and tendencies. We have seen in recent years a gradual readjustment of our school curriculums in accordance with new ideals of subject-matter and methods of instruction. The teaching of the natural sciences, for example, has been completely revolutionized.

And now there are indications that the apparently invincible fortress of mathematical pedagogy is to be touched by the genius of progress. The movement is not confined to this country. In England its most eminent exponent is Mr Perry. The vigorous Herbartian school among the German educators is applying to mathematics the wonderful ideas of apperception and correlation, and insists on psychologically correct methods of instruction.

During two visits to German schools within the past five years, I noticed a decided tendency in this direction. The work of Professor Kumpa in Darmstadt is specially noteworthy. He correlates mathematics and manual training. With great care and labor he

has worked out a complete set of laboratory exercises in geometry. His system may be secured at very moderate cost by addressing him. In the Reform gymnasium at Frankfurt the classes in solid geometry used detachable tubing to build the solids. Several firms are selling simple outfits for plane geometry. [K. G. Scheffer, Lehrmittel-Abteilung, Leipzig].

This reaction, like every other, may be in danger of going too far at first. It will be necessary then for teachers to travel very cautiously on the new road. To be able to welcome the new, one must have been dissatisfied with the old and must have recognized the superiority of the new. Elaborate demonstration is not needed to show that our traditional way of teaching mathematics in the elementary and secondary schools is open to severe criticism, if we view it in the light of modern psychology and educational theory from the standpoint of the learner, and if we compare the enormous display of energy it demands with the actual results. It is only necessary to point out the large percentage of "failures" in spite of the heroic efforts of teachers and pupils and the unquestionable unpopularity of mathematics. These symptoms are often wrongly interpreted as confirming evidences of the educational value of the subject. It seems axiomatic that a subject so immensely practical and so generally indispensable should, if properly taught, strongly attract the average high school student instead of inducing in him a lasting aversion and a state of mental nausea. This picture is not overdrawn.

But what is the "laboratory method of teaching mathematics"? First of all, a few negative remarks. It is *not* an attempt to rob mathematics of its ideal, intuitive character. In fact, the old struggle between the empiricism and transcendentalism is entirely out of place in the modern high school. The millenium will probably witness the final settlement of that question, "Adhuc sub judice lis est." President Hadley in a recent paper says, "We no longer seek to maintain standards; we seek to accomplish results."

There have been strong protests, it is true, against time-honored Euclid. The salient point of these, however, is that Euclid's *System* was not intended for immature boys and girls, but for men possessed of strong philosophic inclinations. The objection is *not* so much to the *demonstrative method*, as to the formidable array of propositions which form a logical nexus that does not throw the essentials and nonessentials into proper relief. In a certain sense, of course, nothing is unimportant. At the same time, this concededly splendid edifice, a source of inspiration to the mature logician, is to untrained

boys and girls simply awe-inspiring. This is particularly true when nothing in the preparation of the pupil bridges the chasm between the elementary and secondary school, when he is compelled to acquire his knowledge of space *forms* and space *laws* at the same time. A hopeless confusion often results. To claim that a course in geometry differing by a hair's breadth from the customary iron-clad outline is not true geometry, seems decidedly pedantic. Just as soon as the pupils coming to us from the primary schools shall have had a complete course in concrete, observational geometry at the hands of trained teachers, and an introduction to methods of demonstration, so soon will a study of "rigorous geometry" be possible and profitable in the high school, and not sooner. Furthermore, the laboratory method in mathematics does not substitute *induction* for *deduction*. An appeal to the senses, specially during the earlier stages of the work, is not necessarily an abandonment of rigor. It simply clarifies and confirms the learner's space notions and his grasp of the laws in accordance with the famous motto, "Quod non est in sensu, non est in intellectu." We do not hesitate in our elementary schools to illustrate numeric relations concretely, and yet we do not entertain any fear that the children on that account might be unable to comprehend the underlying general principles. The reverse is true.

For an admirable exposition of the laboratory method, I must refer to what seem to me the best simple monographs on the subject.

"Laboratory Methods of Teaching Mathematics in Secondary Schools," by Adelia R. Hornbrook. Amer. Bk Co. 1895. [10*c*].

"The Laboratory Method in the Secondary School," by Prof. G. W. Myers. College of Education, University of Chicago. The School Review. November 1903. University of Chicago press. [20*c*].

The latter article is specially valuable as it contains the description of a "fairly complete equipment for a mathematical laboratory."

I will be pardoned if, in conclusion, I quote a few of the principal ideas of these writers. Mrs Hornbrook says:

The term "laboratory method," borrowed from the vocabulary of natural science teaching and applied to that of mathematics, denotes the method of independent personal investigation on the part of the learner under the leadership of a teacher who furnishes only the necessary aids to interpretation. By its means it is hoped to make the advance of each learner a triumphal progress. In many cases the requirement to possess a certain degree of mathematical ability is as much beyond the power of the pupil as would

be the requirement to possess a certain hight. The use of laboratory methods in elementary mathematics requires only the ordinary classroom supplies with the addition of a small library of mathematical works. Before beginning demonstrative geometry, the classes take a short course in concrete geometry. A few weeks devoted to concrete geometry as a preparation gives great gain in time and ease in studying demonstrative geometry. After a certain power of insight is gained, the study is no longer wearisome, but is a delight.

According to Professor Myers,

Laboratory method means *work*—work *on the pupil's part*—or, better still, ***method of getting work done by the pupil on his own initiative, under the impulse of his natural interests, and largely under the guidance of his own intelligence.*** The laboratory method merely condenses to its essence the old, but ever new pedagogic maxim: "Learn by doing and do while learning". It commands the traditional formalist to face knowledge and knowledge-getting from the standpoint of the learner, rather than from that of the masters.

The *way of getting school work done* is of much more consequence than is the mere doing of it. The most telling weakness of current mathematics teaching is that it makes so feeble an appeal to the will. The laboratory in secondary mathematics calls for right doing as well as right thinking. Importance of *real* problems. Correlation of mathematics and the metrical sciences. To answer these momentous questions from the standpoint of the mathematical teacher is the supreme mathematical problem of the age.

See articles in the *School Review, Educational Review, The Monist, Journal of Pedagogy, Education* etc.

THE TEACHING OF GEOMETRY

BY W. BETZ, EAST HIGH SCHOOL, ROCHESTER

With much reluctance and only by request, I submit the following "Suggestions to teachers." They are essentially in the form in which they were offered to the teachers of mathematics in the East High School, Rochester N. Y., at the beginning of this school year. Whatever criticism they may deserve, they are at least flexible enough to leave full scope to the individuality of the teacher.

1 The genetic or development method is recommended. [See Young, J. W., The Teaching of Mathematics in the Higher Schools of Prussia. Longmans, Green & Co. 1900].

2 The application of the "five formal Herbartian steps" will be found very useful. In the hands of an experienced teacher they will make a good recitation not an accident, but almost a certainty.

3 In large classes specially, oral recitations are to be preferred to written ones, as it is easier to keep the entire class busy profitably. [*See* Regents Syllabus, High School Bul. 8. April 1900. p. 91].

4 Overcome the usual dryness of the subject by introducing concrete, interesting illustrations. [*See* Campbell's *Observational Geometry*, Spencer's *Inventional Geometry*, Hornbrook's *Concrete Geometry* etc.]

5 In general, give "first the idea, then the word." Use models freely, specially for first developments, but *not* for review, when mental diagrams may be substituted.

6 Leave the pupils each day with some problem or question. These questions should be simple at first and accompanied by suggestions. Make "problem solving" the rule, *not* the exception. In fact, each proposition may be taken up as a problem.

7 Theorems

a General considerations

In the first place, some of the best authorities uniformly caution against rigid demonstrations of practically self-evident truths. Such proofs may be of great interest to the philosopher, but can not possibly attract immature boys and girls. An interesting discussion of this question is found in the *School Review* of December 1903.

Prof. E. H. Hall mentions as an instance the proposition: "If one straight line meets another straight line, the sum of the two adjacent angles is equal to two right angles." He says:

Now that is, I think, a perfectly self-evident proposition. Any boy who looks at it with the figure before him, *sees that it is true; and* when he is asked to *prove* that it is true, he is in this state of mind: "Either the person who asks me to do that is an idiot, and I do not know how to reason with him, or I am an idiot."

Professor Hall then quotes the usual proof and continues:

By the time the boy has got through that, I think he is in doubt. Of course this can be justified in a way. We know what geometry is. Geometry is a rigid course of reasoning, where you start with certain agreed-upon material, certain agreed-upon axioms and definitions and you are to use those only. But I think it is unfortunate to apply that machinery to a problem that is self-evident from the very start. The boy ought to use that machinery at the very outset to prove something which he can not prove without it. This proposition starts a boy with a discouraged, helpless feeling which it takes weeks to get over.

Mr Francis [of Phillips Exeter Academy] thinks that the "critics" are responsible for this useless material in our books.

A "critic" finding that thing lacking would say: "The book is lacking in rigor." "That is the end of it; you can not *sell* the book."

If, then, we can not get the right book, we can at least eliminate objectionable matter after due consideration.

In their endeavor to cut out the dead matter some purists in the profession go too far. Mr J. C. Packard of the Brookline [Mass.] High School suggests that we omit limits, incommensurables, and the derivation of π.

Even Prof. G. Chrystal [University of Edinburgh] excludes from his *Algebra for Secondary Schools and Technical Colleges* the treatment of subjects that depend on the theory of limits and convergency. He says:

> The premature introduction of such subjects with loose and even misleading or false demonstrations has been one of the most glaring defects of our elementary mathematical textbooks. In this respect it is scarcely too much to say that many of them are half a century behind the age. Not only is teaching of this kind a *waste of time,* but it is an absolute obstruction to further progress. How deplorable the results are is well known to every examiner and university teacher.

According to the same writer, nothing but a *compromise* between the two opposing schools of mathematicians seems practicable at present. We are living in a *transition period.* A conscious recognition of this fact will be found very useful. Professor Halsted would make mathematics in the schools more rigid than ever ("rational geometry"). [*See* Educational Review, December 1902. The Teaching of Geometry.] On the other hand, the Chicago educators and their followers eulogize the laboratory and field methods, insist on observational work, and introduce interesting practical problems. One might be tempted to ask, "Which horn of the dilemma shall we seize?" Ultimately, however, it will be seen that each of these conflicting views contains elements of truth which the progressive teacher will gladly embody in his pedagogic system.

Summary

If mathematical instruction is superficial, it is useless. If it is uniformly uninteresting to the average pupil, it is harmful.

b Special suggestions

The following mode of taking up theorems has gradually been developed at this school. It has given satisfaction at least to the teacher who tried it. In his opinion, it avoids extremes and meets some of the best pedagogic requirements of the present day. It

seeks to excite interest, to arouse the self-activity of the pupils, and aims at thoroughness and an intelligent grasp of the subject.

Each theorem is taken up on two consecutive days. The first day is devoted chiefly to development, the second day to review, drill and applications. The work is distributed as follows:

FIRST DAY

1 The proposition is carefully introduced and developed by the teacher by a series of inductive questions. Throughout the process the *entire* class constitutes the working unit. Pass from the known to the unknown, from the particular to the general etc. At first it may be well to use a model. Then a preliminary diagram may be drawn rapidly by the instructor or a pupil. Construction lines are introduced only as they are needed.

Professor Crystal says:

A mathematical truth is not made part of the mental furniture of a pupil merely by furnishing him with an irrefragable demonstration. It is not until he has tried it in particular cases, and seen not only where it succeeds, but where it fails to apply, that it becomes a sword loose in the scabbard and ready for emergencies. The rigorous demonstration is but the *last polish* given to the blade. It is better now and then to lead a learner to *feel the need of a weapon* before we place it in his hands.

2 Hereupon the figure is constructed accurately on the blackboard by the teacher or a pupil, each pupil doing the same on his individual sheet of paper.

3 The hypothesis and conclusion are written in the briefest possible manner. The proof is then given in topical form, each statement being furnished by a different pupil. These statements as they are written are numbered. Each pupil is meanwhile making his individual copy.

4 After the relation of the new theorem to the previous work has been ascertained and some of its applications have been studied, the new lesson may be assigned. Each pupil is expected to review the new theorem at home, comparing the proof of the author, if a text is used, and to bring the next day in addition to the solution of exercises that may have been assigned, an accurate, neatly written copy of the proposition, representing (*a*) a repetition of the blackboard work, (*b*) a *summary* of the proof.

SECOND DAY

1 When the class enters, the figure is either on the board, or is rapidly drawn by a pupil. As the entire class witnessed the con-

struction of the figure the previous day, the use of a finished diagram is not objectionable.

2 A brief oral, topical review of the proposition follows, each statement being furnished by a different pupil.

3 Meanwhile, one pupil has been sent to the board to write these statements as they are given.

4 The entire proof (with reasons) is then given by one or two pupils in order to bring the sum total of the demonstration before the class.

5 Then the written work is erased, and the proof is repeated with figure only.

6 The letters of the figure are then erased and the proof is repeated by a pupil with pointer in hand.

7 A different figure, at the discretion of the teacher, may then be substituted.

8 Finally, the figure also is erased and a mental diagram takes its place.

9 A summary of the proof should be given and the applications of the proposition should be reviewed and extended.

This process seems very complicated, but after a little practice it need not take more than 15 minutes, though the proposition will have been reviewed very thoroughly. Both the particular and the general aspect of a theorem will have been emphasized. Besides, each repetition is conducted in a different manner and monotony is avoided. The recitation has been more varied and more interesting. After a month or two the developments, which at first consume the bulk of the period, will require less time. The entire process can gradually be reduced somewhat, more time being given to original work. The possible criticism that the pupil is assisted too much is not valid, for he must first learn the true meaning of a proof. Besides, the exercises afford ample opportunity of testing his growth in analytic power.

8 Original work

Do not expect very much originality at first. It will be necessary to grade the exercises very carefully, in the order of difficulty and according to methods of solution. Typical problems must be analyzed and demonstrated before the entire class. The methods of solution should be tabulated [see summaries in Milne's *Geometry*]. Each new proposition should be regarded *as a new tool* for the solution of a new set of problems. Let the pupil see some of the possibilities of each theorem. To demand of beginners the solution of complicated problems is like requesting an incipient mechanic

to manufacture a complicated article with tools as yet unknown to him. Analysis and demonstration are arts that must be acquired by patient application.

9 Put questions or give little problems that more or less anticipate the succeeding book work. Avoid some of the difficulties of the subject by throwing out suggestions in advance. Form the "*apperceptive mass.*" Take up each important topic at least twice.

10 Let the pupils find, with their own eyes, ***applications*** of the theorems, in the wide universe surrounding them. Many problems from architecture, domestic science, mechanical drawing, and physics have a geometric basis. The pupils should be impressed with "the utility as well as the beauty of the subject"; it should appear real to them, and not simply an ingenious conglomeration of abstract formulas, delicate instruments of torture. They should be able *to do* as well as *see*. [Rule and principle, theory and practice.]

11 Pupils always enjoy references to the ***history*** of the subject.

12 Associate theorems as closely as possible. Form groups of propositions, e. g. the laws of triangles may be classified as laws of formation, of equality and of inequality.

13 Make the *figures*, as far as possible, self-explanatory, by

- 1 a suitable notation (single letters, position of letters, etc.
- 2 using heavy lines for *given* parts, light or dotted lines for construction elements
- 3 introducing color
- 4 enlarging involved details
- 5 the use of check marks [See Schulze-Sevenoak's *Geometry*]

14 Reviews, specially during the first three months, should be frequent and thorough.

15 The written work should be in ink.

16 Work out your own devices and illustrations.

17 Consult as many standard texts as possible. Read carefully the prefaces to these books, from which many useful hints may be gathered. Some syllabuses are very suggestive. In regard to textbooks, Professor Baker says:

> The textbooks are too much mere collections of definitions, theorems, syllogisms, almost totally devoid of any pedagogic attempt at presentation. Like treatises on natural sciences without analytical tables, they are instructive, but not educational. Instead of being mere didactic skeletons, they should be built upon inductive and pedagogical lines, with an exhaustive series of questions leading the student into the very penetralia of the subject as to the interrelation of parts, tracing the threads through all the interweaving of the web,

tracing the consequences of this, that or the other variation in the chain of syllogisms, seeking the consequences of this omission or that choice of procedure, insisting upon the phrasing of his concepts, demanding the existential reasons for his methods of procedure independent of their logical correctness. They should not only instruct the student by presentation of facts, but they should educate him by the pedagogical presentation of the logical, existential, selective and operational bearings of those facts.

The above papers were discussed by Professors Roe, Sisson, Bullard and Curtiss, Miss Wardell, and Dr Karpinski.

Wednesday afternoon

Joint session of Science Teachers Association and Associated Academic Principals, Pres. Ernest R. von Nardroff of the Science Teachers Association, presiding.

The report of the subcommittee on science was read by Superintendent Bardwell. The Science Teachers Association report was subsequently read by Mr Turner.

REPORT OF THE SUBCOMMITTEE ON SCIENCE

THE PREPARATION OF OUTLINES IN PHYSICS AND CHEMISTRY FOR THE REGENTS SYLLABUS, 1905

BY GEORGE M. TURNER, MASTEN PARK HIGH SCHOOL, BUFFALO

For report, *see* p. 182

Wednesday afternoon

Joint session with Associated Academic Principals

THE PLACE AND FUNCTION OF BIOLOGY IN SECONDARY EDUCATION

BY CHARLES W. HARGITT, SYRACUSE UNIVERSITY

No very extended or critical study of the history of education will be required to show that along with the shifting changes of civilization, its institutions, philosophy, ethics etc., there have been more or less corresponding changes in the educational ideals, standards and methods of various peoples. At times these changes have been so slow as to be imperceptible; at other times they have seemed more like revolutions then evolutions. Out of the noise and smoke of the old battles of the creeds, the conflicts of science and religion, the

stormy contentions of science and the modern culture factors for a place in the curricula of college or school, and the vanishing echoes of the war of words concerning the culture qualities of the several factors of the new education, we have emerged, or are in emergent processes, to find that in many respects these warring contentions had been only modern illustrations of the old story of the color of the shield. The bitterness of the battles of creeds has given place to the spirit and practice of federation and cooperation; the hostility of classicist and radical has largely resolved itself into an armistice of tolerance, if not indeed of amicable readjustment.

While there still remain occasions for healthy polemics over open questions and new problems in education, and anything less would fall short of healthy growth, they are, however, animated by a more catholic spirit, and actuated by nobler motives and higher ideals.

It may suffice, therefore, by way of introduction to say that the purpose of this paper is neither polemical nor concessional, neither apology nor eulogy. It shall be rather a simple and straightforward attempt to point out methods for utilizing the ripening conditions of the educational harvest to the largest good of both pupil and school. The signs of the times seem to me to indicate that perhaps seldom have educational conditions been more favorable for the realization of real health and growth in our State than in these opening years of the new century.

As a further preliminary word it may be well to remind ourselves or perhaps to define to ourselves anew the fundamental aims and ideals of education in general, though with special reference to secondary schools. That we have well emerged from the shadows of medieval scholasticism with its benighted and limited ideals, or from some later notions in which educational purpose was chiefly informational, or which under slightly different circumstances emphasized the cultivation of certain conventional mental or esthetic attitudes, or social bias, there can hardly be serious question. While not indifferent to the good in the older methods and ideals they are no longer regarded as fundamental or incumbent, though to speak thus may incur here and there a lingering protest or criticism. Whether with Spencer we agree that "to prepare us for complete living is the function which education has to discharge"; or with Huxley that "education is the instruction of the intellect in the laws of Nature, under which name is included not merely things and their forces, but men and their ways, and fashioning the affections and will into harmony with these laws"; or with President Eliot that the main object of education is development of power—

"to give to the pupil ability to do an endless variety of things which uneducated he could not do"; or with President Butler that it means a graduated adjustment of the pupil to the changing conditions of environment in science, literature, esthetics, institutions, religion; or with Donaldson that "education consists in modifications of the central nervous system"; or whether we may choose to formulate for ourselves still another expression of the problem, it may be safely assumed that in this consensus of opinion we have a fairly critical definition of prevailing educational ideas and aims, sufficient at least for the purpose of the present discussion.

One need hardly pause to show the intimate relation of biology to these definitions. If Mr John Fiske had left no other contribution to philosophy and science than his luminous exposition of the significance and importance of the period of prolonged human infancy in its relation to the problems of family, social and civil life and progress, it would have sufficed to secure for him an abiding place in the esteem of multiplied generations of his fellows. Almost from its announcement this was seen to sustain intimate relations to education, and in the richness of its fruition along this line it may be doubted whether in the entire scope of educational history, not excepting the splendid contributions of Comenius, Pestalozzi, Froebel or Herbart, and the doctrine of apperception, interest, correlation, etc. anything so fundamental in conception or so pregnant in possibilities has been formulated. "It is," says President Butler, "one of the most profound generalizations of our modern science, and it has enabled us to see to the very bottom of education and to understand the biological significance of one of the most striking and imposing of social phenomena." This may seem strong language, but it is not too strong. When clearly apprehended its fundamental content and far-reaching value as an educational postulate can hardly be overestimated.

If this doctrine of Fiske be true, and every line of evidence bearing on it increasingly confirms it; if in assuming it as his point of departure in seeking the "meaning of education" President Butler is correct, and I see no possible alternative, then as pointed out by the present writer in an address before one of the sections of this conference six years ago, we must accept the deduction that fundamentally and practically education finds its roots in the biologic conditions which constitute the environment of the child from birth through the plastic years of youth, and that as a process it involves the graduated adaptation of physical, mental and spiritual powers to the immediate and prospective environments of serious life.

But what has all this to do with biology in secondary education? We might admit that as educational philosophy the foregoing principles are proper and important without allowing the inference that therefore the subject of biology should constitute a practical part of the school curriculums. We shall see in what follows that this is not the point at issue, nor the ground on which we are proceeding. The fact is that already to a greater or less extent the subject is a part of the recognized "enrichment" of the secondary school course. Our present inquiry has to do chiefly with the questions of place and function.

An examination of the several editions of the *Academic Syllabus* from 1888 to 1900, and the revision of 1905 now in process of adoption, shows that provisional programs of botany and zoology have been offered including suggestions and directions for teaching. A comparison of these several editions will reveal an interesting evolution of both matter and method. The syllabus of 1891 installed the distinct division of "biologic science," including as at present botany, zoology and physiology. But there was nowhere apparent in the earlier edition the distinctly biologic point of view. The plant types recommended were all of one series, the phenogams or flowering plants, and in zoology little or no attention was given to laboratory work. In the edition of 1895 a distinct step in advance is evident in that emphasis is placed on "investigation of facts rather than acquisition of facts."

Similar improvement is evident in the edition of 1900, where for the first time the distinctive biologic point of view dominates more or less the development of the courses and the methods given. It is in the report of the subcommittee on syllabus which is to have your attention, and I trust approval, that something approximating a truly scientific provision for these courses, is clearly evident. The report postulates the importance and "advantage for pupils to study animals and plants in their relation to each other." Unfortunately, however, almost immediately this ideal is apparently dropped and independent courses in botany, zoology and physiology are provided, in each of which I should think is prescribed sufficient work for an entire year. Let us not overlook the ideal of biology—not the multiplicity of facts, not the large and but slightly differentiated members of a group, but the relations of facts, the significance of likenesses and differences, factors of adaptation and homology, fundamental processes of nutrition, growth, metabolism, reproduction etc. Why not the morphology and physiology of living things, animals and plants conjointly and comparatively, throughout the entire year.

rather than botany, zoology and physiology as distinct and more or less independent courses?

As to the place of such a course in the curriculum much may be said pro or con in reference to the recommendation of the report placing it in the first year. It would seem that putting the advanced courses in botany and zoology in the last year leaves an unfortunate interregnum between the two, and utterly divests the subject of that continuity which ought to be an important feature here as elsewhere.

As a final word concerning the place of biology in the course, or whether indeed it have any place, I would beg to insist that it be governed by a still more important consideration, namely, the teacher. Though biology be one of the most absorbing, and at the same time one of the most stimulating and disciplinary courses, yet I am firmly convinced after some 20 years of personal experience and observation, that it is one of the most difficult to successfully teach. Therefore I would say that if the alternatives be no biology, or biology indifferently taught, the former is by far to be chosen.

But it may be asked why there should be difficulty concerning the teacher? Are such teachers rare? They are not numerous under prevalent conditions, which ordinarily involve some half dozen other subjects of the most diverse sort. They are not of spontaneous origin—do not arise full-orbed at the nod and beck of every school board. Unlike poets, who are said to be born not made, biologists have to be made as well as born, and the former process is quite as important as the latter, neither of which is unimportant. For in addition to the special fitness which is only obtainable under the proper environment and tuition, there must be the inborn, throbbing biologic soul, alive and responsive to the soul of nature. Such teachers exist and are obtainable.

Nevertheless, I plead for biology in the schools. Biology rather than botany or zoology, singly or in successive courses. Biology means more than either alone, is more than either. It proceeds on the postulate that organisms are living, acting, interacting, sensitive, irritable, responsive and adaptive to a degree seldom realized by those untrained to observe. They live, struggle, thrive and achieve, or suffer, decline and perish.

> For life is not as idle ore,
> But iron dug from deepest gloom,
> And heated hot with burning fears,
> And dip't in baths of hissing tears,
> And battered by the shocks of doom
> To shape and use.

It is the province of biology to scrutinize these manifold aspects of life, to resolve the intricate web, unravel the tangled mazes, to correlate them into rational science.

It is not to be inferred that nothing of this inheres in either botany or zoology, particularly in those modern departures known as oecology, still the fact remains that they belong distinctively to biology rather than to either of the others alone, in which we are for the most part concerned with anatomy, morphology, physiology or perhaps embryology. These are far from unimportant. On the other hand they have a place peculiarly their own. In the mazes of morphology there is a discipline unique and unsurpassed. In comparative anatomy is a drill indispensable to the prospective medical student, without which he must miss much that is fundamental in the scientific aspect of his calling.

Moreover, in both botany and zoology are afforded opportunity for the development of a feature too much tabooed of late, namely, taxonomy or systematic work. While the old methods may have over-emphasized this aspect of the subject, still there is here a means of discipline not to be despised, specially if associated with ample drill on the morphologic data which underlie scientific taxonomy.

Again, since there is a growing provision for such critical courses in these subjects as will render them acceptable as college entrance options, it may be safe to assume that greater emphasis is likely to be placed on them as independent courses rather than as joint courses in biology, though in many cases both are likely to obtain in practice, it will not be wide of the present discussion to urge that whether the one or the other idea predominate, or whether the entire time be given to botany or all to zoology, that in any case the subject be approached from the biologic point of view, and that whether the type idea, or some other govern in the course of instruction, the teacher do not for a moment lose sight of the biologic conception, that all organisms, whether animal or plant, or sharing characteristics of both, are living, responsive, adaptive individualities, or are products of fundamentally indistinguishable biologic forces and laws, and that however diverse may be an organ or tissue, in a last analysis the vital processes are essentially similar.

Concerning the function of biology in secondary education it will only be possible briefly to cite some of the more important features.

1 **The revelation of the living world.** From birth to death we are in the midst of a living environment. All nature is throbbing with life—the air we breathe, the earth on which we tread, the

rivers, the sea—all are the teeming homes of an infinite progeny of life. The vital procession continues in unbroken succession from that far-off time when in some happy conjunction of synthetic elements protoplasm had birth, on through the present fulness into the beckoning future where Utopia may be no longer the baseless fabric of a dream but startlingly vivid with reality.

Of this we are part and parcel, dependent on the same fundamental conditions of environment and struggle as are other of nature's children. And this it is as much the privilege and right of pupils to know and appreciate as it is ours. It is one of the functions of biology to bring home to the consciousness of these youth the fact that there is a unity and correlation of vital law common, not only to animal and plant, but to themselves as well, and that moreover, there are bonds of dependence and interdependence, if not indeed, of interrelation, which it is of the utmost importance to properly understand and appreciate. A single illustration without details will suffice to justify the assertion, namely, the fact of the well known causal relations of some of the simplest of the vital progeny, germs or microbes, to not a few of the most virulent and dreaded of diseases, some of which are common to animals and man.

Familiarity with a few of the simplest of these facts on the part of even pupils might be sufficient to insure the healthy growth of correct sanitary principles and practices, which in turn might easily suffice to materially augment the sum total of human longevity by several years, and at the same time greatly increase the sum of human happiness by reason of having relieved the mind of much of the dread anxiety which now so largely associates itself with various forms of human malady, by giving to every intelligent person a rational insight into both the cause and remedy. In like proportion as the present generation has no longer the haunting nightmare of witchcraft and kindred sorceries may later generations be relieved of lingering relics of similar sort which harass this. If any special vindication of this claim were needed beyond that intrinsic in the nature of the subject it would be easily obtainable. To a personal friend of mine, one of the most eminent of American physicians said during the fearful epidemic of fever which decimated our armies in a single camp many times over all that suffered in all the battles of the Spanish War, "If our volunteer soldiers in Florida and Cuba could have known but the simplest principles of bacteriology, and something of the relations of bacterial organisms to disease, we should not be reading these dread reports of typhoid

fever." These simple principles come easily within the understanding of average pupils of the secondary schools, and within the scope of an elementary course in biology.

2 **Generation, heredity and kindred problems.** Of the thousands who graduate from the secondary schools comparatively few will ever be able to pursue their education in the college or university, or have other opportunity to gain an insight into that most vital of all problems of biology—generation and heredity. If the highest level and average of human vigor and perfection is ever to be realized it must be through some method other than a defiance of the simple and fundamental laws of biology which underlie generation and progeny. Shall we look with admiration on the rich perfection of the fruits of an intelligent application of these laws to the endlessly varied products of field and stable, and then with dull stupidity bewail the endless line of human degeneracy, pauperism and imbecility? We may, just so long as we surround the whole institution of human matrimony with a shroud of maudlin sentimentalism and stupid ignorance and leave every generation to repeat the follies inseparable from such a course. In this attitude and suggestion there is no occasion for prudish hysterics. The entire subject may be unfolded and developed in mixed classes in secondary schools in the course of a study of the simplest organisms in the laboratory, and without raising so much as the suggestion of indelicacy or impropriety. With fundamentals clearly understood in relation to these laboratory organisms, or in the myriad flowers which deck a summer landscape, or in the life history of a simple angleworm, their significance and bearing on human weal will not be overlooked or mistaken, though not a syllable of direct suggestion be made, if such a precaution be considered important.

Correlated with instruction along these lines, indeed almost inseparable from it, may be most effectively inculcated the scientific aspects of narcotics and " temperance physiology." Simple experiments on the developing egg or embryo of fish or frog will afford both illustration and demonstration that need no declamation or citation of authorities in order to secure conviction of truths which lie revealed before the eye of the observer.

I would not be misunderstood on this matter, where clear thinking and lucid utterance are so important and too often lacking. It would not be essential to contrive these experiments and exhibit them for the express purpose of enforcing a moral precept or an ethical principle, but rather as they may incidentally come out in the usual and steady prosecution of the work of the course. It is

partly in the inculcation of the scientific habit of thought and work that these lessons force themselves on the attention and win conviction. It needs no gift of prophesy to forecast the suggestion that the only final solution of any of these problems will come through the safe and sane methods of science critically applied. Whatever may have been the merits of the method of settling matters of ethics or practical life by "authority," it has probably passed the zenith of its conclusiveness and its future is one of waning power. Sooner or later even pupils will discover for themselves ways of discerning the truth of this or that lesson or dictum, and if adversely, so much the worse for the case.

3 **Biology and the scientific method.** It has already been suggested that in the acquisition of the critical methods of the laboratory there comes a satisfying sense of certainty and finality in the search for truth. There is nothing intricate or abstruse about this method; it is, as Huxley long ago pointed out, "trained and organized common sense." It involves no mystical or occult processes, no legerdemain, no superior order of mind, simply critical and laborious study of facts and inflexible honesty and courage in their interpretation. Both the method and spirit imply rather an attitude of mind than a special endowment of power and sense. While often associated with the laboratory idea, and always involved in honest laboratory work, yet it is not limited thereto. As an attitude of mind it will be found wherever one is honestly engaged in the quest of truth. An eminent classicist [Jebb] has said "the diffusion of that which is specially named science has at the same time spread abroad the only spirit in which any kind of knowledge can be prosecuted to a result of lasting intellectual value." It remains true, however, that educationally this method is seen to best advantage in laboratory practice, where tangible and ponderable problems pertaining to things are taken up and prosecuted to inflexible and unquestionable results. The facts and phenomena of chemistry and physics afford conspicuous illustration of the idea. The facts and phenomena of biology differ widely from the former, involving data often devoid of the ponderable and tangible, yet not the less real or important, indeed in an important sense more so, if possible, still the methods of their demonstration are essentially the same in principle though involving varying differences of detail according to phenomena.

To acquire this concept and attitude must constitute one of the most fundamental of all educational endowments. Ex-President Gilman in an important address before the Association of Colleges of the

Middle States and Maryland said " The liberally educated man should also be acquainted with the principles and methods of scientific inquiry. Such knowledge does not come from reading books or attending lectures. As a general rule it can only be secured by prolonged courses of observation or of experiment, and these courses can rarely be advantageously followed without the various helps that are provided in modern laboratories." And herein lies the justification for the large development of the laboratory idea in all departments of school work where it can be profitably employed, that is, chiefly among the sciences.

To quote again from Huxley, our pioneer in laboratory biology,

No boy or girl should leave school without possessing a grasp of the general character of science, and without having been disciplined more or less in the method of all science, so that when turned into the world to make their own way, they shall be prepared to face scientific problems not by knowing at once the conditions of every problem, but by being familiar with the general current of scientific thought, and by being able to apply the method of science in a proper way when they acquaint themselves with the conditions of the special problem.

4 **Biology and culture.** It may not sufficiently satisfy the demands of educational philosophy that a subject develop keenness of intellect or skill of eye or hand. The idea of culture is often demanded and rightly so in its true educational sense. Not, however, in the merely conventional sense—the pose of body or inflection of voice or those social proprieties which too often pass for culture, in the possession of which there is most often the pharisaic spirit which thanks God he is not as other men.

If on the other hand we look on culture as breadth of view, largeness of soul, affectionate interest in human weal, the mental perspective which comes from generous cultivation of its powers, then it will not be difficult to see the relation of biology no less than other factors as a means of realizing it. Martineau, free from the bias of the scientific specialist, says of culture,

It secures a genuine liberality of mind, a sympathy with whatever makes man intelligent, gracious and noble, and a delight in rendering this, as far as possible, common of all. . . and he in whom it is represented is an epitome of the higher faculties of our life.

Eliot says of it,

The worthy fruit of academic culture is an open mind, trained to careful thinking, instructed in the methods of philosophic investigation, acquainted in a general way with the accumulated thought of past generations, and penetrated with humility.

That biology holds the key to no small measure of the truth of nature will not be seriously called in question by any well informed mind. If love for truth and diligence in its quest enter into our concept of culture, then again it must be evident that our science has within it the potentials of large and varied culture.

Again, the realm of nature has ever been the infinite source of the beauty which has ravished the soul of humankind from long before its climax in the supremacy of Greek science, art and philosophy. To portray some fragmentary phases of this rich treasury has been at once the ambition and despair of painter and sculptor. But for its adequate appreciation some insight into its biologic history and relationships would seem almost self-evident. Some one has compared nature to a splendid gallery filled with the masterpieces of the creative genius of the great artist and architect of the universe. We may grant the comparison; but at the same time have a right to ask who is to best perceive and interpret all its aspects of grace and beauty? If biology holds the key to it one outside its scope must be relatively as one who would master the riches of the Louvre or Vatican with a veil over the eyes, or as one seeking to interpret a gallery of pictures whose faces had all been turned to the wall.

But nature is more than a gallery into which may stroll the listless vagrant who would while away life's fitful hours. It is rather a laboratory or studio, where there are problems to be solved, or where truth and beauty await form and expression.

If someone should remind us in this connection of the ancient motto which adorned the archway of that heathen temple and admonish us in its language, "Know Thyself," or should recall Pope's modern paraphrase of the same sentiment, "The noblest study of mankind is man," it may suffice to say in response that biology through the doctrine of evolution and the establishment of the cell theory of development and heredity, offers the only scientific approach thereto, and may therefore safely accept the challenge.

In striking confirmation of this claim Agassiz, who despised the doctrine of evolution and knew nothing of the significance of the cell theory, has eloquently declared

Man is the crowning work of God on earth: but though so nobly endowed, we must not forget that we are the lofty children of a race whose lowest forms lie prostrate within the water, having no higher aspiration than the desire for food; and we can not understand the possible degradation and moral wretchedness of man, without knowing that his physical nature is rooted in all the material characteristics that belong to his type, and link him even with

the fish. He may, if he will, abjure his better nature and be vertebrate more than man. He may sink as low as the lowest of his type, or he may rise to a spiritual height that will make that which distinguishes him from the rest far more the controlling element of his being than that which unites him with them.

Whether this feature should constitute a phase of the several functions of biology in secondary education, or merely sustain an inferential relation, as in certain other points, may be an open question. Personally I should deprecate the introduction of any considerable measure of the speculative aspects of biology into these courses, and particularly those concerning which data are not abundant and far more difficult to correlate and interpret. These are problems for the expert and specialist, and however interesting in themselves could serve no distinctively disciplinary or primary educational ends. They may be safely relegated to such later period, either in the college course, or in the educational and informational period of mature thought in the later life of man or womanhood. The all important end will have been secured in the more fundamental work of the laboratory, or the field, or the seashore—in the open mind, the observant eye, the critical faculty and the mature judgment in dealing with facts and principles and phenomena of nature. With these ends attained it will be safe to assume that where there is the inborn or acquired love for, and interest in the great world of life, from its simplest to its most complex forms, some way for their exercise will be found, or at any rate the capacity to appreciate the various economic, sanitary or cultural significance, will not be lacking.

Prof. Howard Lyon—I feel that I know more about dynamos than I do about electric eels and so regard myself as somewhat incompetent to discuss a paper on biology. However I have some positive convictions concerning the scope of biologic study to be presented in secondary schools. It has always seemed to me that the study of physiology and anatomy were ill-suited to the interests of secondary school life.

The remark of a child illustrates to my mind the present, and as it seems to me, ill-advised trend of biologic teaching. The pet cat of a friend's household had died and in due time it was buried and a marker set up stating that Fuzzy had been a good cat. In sympathy a caller said "Mary, you will miss Fuzzy, won't you?" Instantly the child replied "Yes, but we will have the pleasure of his grave."

In biologic work the pleasure of the grave, of the dead thing, has been too much substituted for the interest in the living thing.

For secondary school work the study of living things seems best suited to fitting a youth to enjoy and appreciate the natural world. If school life ends with the secondary school, the training will be adequate for the average citizen. If a youth is planning to become a biologic specialist as a teacher or a physician, the college will naturally complete the training along the lines of physiology and anatomy.

The study of hygiene, of plant varieties, of growth from seeds, of useful fruits, roots, woods and fibers, of the varieties, lives and haunts of animals could be undertaken in the lowest grades and continued in the high school. In the high school the work could profitably take the turn toward systematic botany and classification of animals based as far as possible on external qualities. A little thought will convince one that there is an abundance of topics of study along the lines indicated.

It seems to me that botany as presented in Professor Bailey's *Plant Life* is splendidly adapted to the interests of youth.

Unfortunately no account of animal life seems quite so attractive in that field as the work named above for plant study. In connection with the study of plants one is naturally attracted to various lines of earth science—specially to the nature of soils, fertilizers, weather conditions favoring the growth of plants—to plant pests and the means of their extermination. In short, all study bearing on successful agriculture is full of value and interest. Commercial geography as presented in Redway's works might be substituted with great profit for dissection work in biology; and seems well adapted to a commercial age that seeks to make human beings comfortable, happy and strong.

I learn by questioning that classes in biology have dissected clams and are able at graduation from the high school to make drawings of the organs of the animal and to give the technical names that apply to the same—and yet are not able to go out in the woods and name six forest trees in their winter garb or identify a dozen familiar birds. If I were to suggest the scope of biologic work that would have most cultural value in the life of the average citizen I would earnestly urge greater attention to the study of living forms, and of the woods, fruits, textile fibers, gums, tissues, foods, and of that endless variety of organic products that contribute to the wealth and prosperity of nations.

Wednesday evening

JOINT SESSION

THE NEW YORK SECONDARY SCHOOL SYSTEM

BY ANDREW S. DRAPER, COMMISSIONER OF EDUCATION

Mr President and Ladies and Gentlemen: Thanking you, Mr President, for your too generous words, and you, my friends, for your cordial welcome, I tender you my sincere acknowledgments and add my Christmas greetings and my congratulations upon the reassuring outlook of the opening year. The attendance at these different and flourishing associations of New York teachers, combined with the experience in other states, seems to prove that the holiday week is the natural time of the year for large meetings of teachers. In about all but the name these meetings form the counterpart of the great state associations which will meet at the capitols of all of the western states in this Christmas vacation and which will leave a lasting impression upon the educational work of half of the country. It is very desirable to make a show of numbers. We each feel a little prouder and a little stronger when we have a part in these large gatherings, which always leave definite impressions upon the people.

The time of the year, the business that brings us into association, the public expectations that encompass us, and the general confidence and prevailing hopefulness of the situation are all heartening.

It is the Christmas season. How much that means in human life! It turns thought to the stars: it begets the effort of souls to chime with the music of the spheres. In celebration of the most stupendous event in either religious or secular history, the busy world stops at this point in the "circle ot the golden year" and blesses itself with songs of thanksgiving and gifts of love.

The work of the schools accords with the spirit of the Christmas week. Work gives trend and tone to the lives of workers. Our work gives added warmth to the inevitable good fellowship of an holiday assemblage and gathers truer impulses and nobler inspirations from the generous and joyous atmosphere of the Christmas celebration.

But there are some sobering elements which must enter into our deliberations. We represent a people and look to a future. It is a great people and a long and an all important future. No other people have such gigantic and unlike factors of population. There are

700,000 Yiddish-speaking people in the heart of the city of New York. We recognize the fact and reckon with it. No other American state has been so uniformly courageous in assuming the burdens of popular education and in placing them upon the resources which ought to bear them; no other state has a better appreciation of present exigencies, and no other is more determined to maintain an educational system which shall meet the future needs completely. The face of the Empire State was never to the rising sun more squarely than now. With an hundred millions for the canal, education must surely have the money that it needs. New York will continue to hold the gateway to the "long house" and her men and women will continue to do things. Of all the things to be done, popular education must have the first and best attention and whatever support it needs. It is not more a matter of money than of plan and method; not more a matter of legislation than of the spirit of men and women; not more a matter of theory than of intelligent appreciation of conditions and of patriotic and cheerful fellowship. It makes the touch of elbows more agreeable and comradeship of more moment in these holiday associations of New York teachers.

But happily the outlook of this particular year is full of promise. The state is in the aggressive mood. The educational forces are united. We must differ in judgment upon details, but we will come to conclusions through discussion. Mere influence or mere volubility or mere anger or mere selfishness will not count. We will come to understandings and then we will put our forces together in executing them. Until we are reasonably agreed upon any important move, we will hold it in abeyance. When we are reasonably agreed upon a policy we will put it through. The way is open. We have had the educational convulsion of our generation. A long road stretches before us. We will travel it together,—city schools and country schools, public schools and private schools, elementary schools and secondary schools, and colleges and universities and professional schools and special schools for the unfortunates, and libraries and study clubs and museums, and all of the instrumentalities for uniformly diffusing knowledge, for extending and enlarging popular enlightenment, for raising the level of a people's intellectual life—we will all fall into the system and go along in company. And whatever we do shall be made to conform to pedagogic principles as we understand them, to the best interests of all of eight millions of people, to the expectation that we are to have an educational revival from Oyster Bay to Dunkirk, and to all the exigencies of the rather serious task of perfecting a sane and bal-

anced educational system which shall be equal to the support of free institutions and not a whit behind that of any other state in the Union or of any other people in the world.

This is a good resolution for this Christmas meeting. If there are any who refuse to take it we are sorry. One is happier in marching with a procession than in sitting by the roadside and seeing it go by. If there is one who would turn back from the splendid sunlight of a resurrection to the leaden skies and the quaking earth of a crucifixion morning, it is time for proceedings *de lunatico inquiriendo*. By far the greater part of us are going on with this state. We are going to aid in maintaining its primacy and we are going to make its destiny as great as we can. We are going with a great throng who will do things, and we are going to have part in the doing. We want every one, of whatever clan or party, to go with us in promoting interests which are common to us all. And whether each one of us shall be able to do little or much, we guarantee that the very effort will bear the assurance of a gladsome New Year to all who will *strive* to have a share in the work of the world.

The secondary schools

All that I have said is, of course, a prelude. I have set for myself tonight the task of discussing our system of secondary schools. I expect to speak of the history of these schools but not to present anything like a history of them. I shall treat of the thought that has brought them to their present state but shall lay no claim to capability for a philosophical examination of their organization, their work, or their relations. In due time Doctor Edward J. Goodwin, the Second Assistant Commissioner, who is in immediate charge of this field, out of wide reading, deep thinking and ample experience, will do all that. I expect to present some observations concerning the future of these schools and their relations to the educational system and the people, but upon the distinct understanding that any suggestion of mine concerning policies not yet concluded is made to my associates in the teaching force rather than to the Legislature and is subject to revision in the light of a wider and more illuminating discussion.

There are 145 registered academies and 655 registered high schools, or exactly 800 approved secondary schools in the University of the State of New York. The figures stir recollections and investigations and exemplify an advance both remarkable and resplendent.

It is not for me to say that this system has reached anything like its best form, nor to think that it is yet doing anything like the work we may well expect, but when I read this paragraph from perhaps the best piece of educational history published in the last year by one of the first half dozen professors of education in American universities, I gain confidence that the system is not so very bad. Professor Brown of the University of California, in *The Making of the Middle Schools,* says:

> If the University of the State of New York had a rather vague existence in the earlier days, there has been no doubt of its place among the actualities in more recent times. The spirit of organized activity has been at work in the institution, with all the stirring, straining, and collision of diverse purposes which commonly attend that spirit's operation. The strongly centralized administration which this unique establishment embodies has been railed at and glorified, but it has gone on organizing, and organizing still more, until it has become a force to be reckoned with in the making of our higher grades of instruction. It can hardly be doubted that this university now presents the most thoroughly organized state system of secondary education which has yet been developed on American soil.

That is competent opinion from the outside. The courts would say that before that could be cast aside it would have to be distinguished *rather closely.* If competent in any court, it ought to be convincing in a New York tribunal.

But let us look at the process of evolution. There have been three fairly well defined steps in the making of American secondary schools. First there was the Latin grammar school of the colonies. Second came the academy, which prevailed and flourished from the Revolutionary War till past the middle of the nineteenth century. And third the public high school which has come into its estate in the last half century.

The colonial grammar school

The colonial grammar school took its name and its character from the early cathedral grammar schools and the monasteries. There were not many of them and they were for the greater part both local and temporary. They were in almost every instance fitting schools for the colleges. They did not scatter their affections. Each one was the instrument and feeder of a particular college. They prepared pupils for the college entrance examinations, but they had to go far to supplement the meager instruction received in the home schools, or perhaps oftener in the homes where there

were no schools at all. Of course they observed and inculcated the religious beliefs of the colleges which they supported.

The character of the New England grammar schools at the middle of the 17th century will be seen from the statement that "When scholars had so profited at the grammar schools that they could read any classical author into English and readily make and speak true Latin, and write it in verse as well as in prose, and perfectly decline the paradigms of nouns and verbs in the Greek tongues, they were judged capable of admission in Harvard College."

At Princeton, a century later, "Candidates must be capable of composing grammatical Latin, translating Virgil, Cicero's Orations and the four evangelists in Greek, and must understand the principal rules of vulgar arithmetic," and this controlled the work of such grammar schools as there were at that time in the Middle Colonies.

These schools are commonly called "free schools," but they were not wholly free. They claimed tuition fees, depended upon generous gifts which they often secured, and looked to permanent endowments which some of them realized. Often gifts of lands or some special revenues were made by the town. Certainly they were not public in the sense that they were supported by uniform taxation. The term "free school" seems to have been used to designate schools not restricted to a particular class of pupils.

New England led in the formation of these early classical schools because New England was *New* England. Institutions in New England naturally enough copied institutional life in Old England. The English peasantry had no schools. The English nobility and aristocracy maintained colleges and fitting schools for their own. The grammar schools like the colleges of which they were really a part came from the higher classes and were necessarily exclusive. There was a fine aristocracy, indeed a gifted and, speaking relatively, a learned aristocracy in New England and naturally enough it followed the ways of the mother country. Often it improved upon those ways. The growing spirit of democracy made this particularly true in education.

The Dutch were the first to set up the really free elementary school in America. They brought more democracy with them than the Puritans did. The Pilgrims had more of it, man for man, than either; but there were not enough of them to bring a very great quantity or propagate it very rapidly. Before the English overthrew the Dutch there were many elementary schools in New Netherland. There were only one or two grammar or classical schools.

After the English triumphed all of the Dutch schools disappeared. Education was a bone of contention. The English had no disposition to encourage elementary schools for Dutchmen. It seemed perilous to them. In the more than a century from the English invasion to the Revolution there were two and only two schools established by the Dutch with the English official approval. Both were grammar schools. The English crown could tolerate Dutch classical schools rather than Dutch elementary schools. That much seemed reasonably safe when the teachers had to be approved by English bishops. One of these schools was as transitory as classical; the other was splendidly persistent for it merged into Columbia University.

Rise of the academies

There is nothing more interesting in our history, or in any history, than the relation of the democratic to the educational advance. The growth of sentiment and feeling which forced the Revolution was quickly reflected in innovations upon the character of the schools. The Colonial grammar schools were pushed down into unoccupied territory from the exclusive institutions of such aristocracy as there was. They were the instruments of a distinct copartnership between church and state. They were commoner and stronger where that copartnership was the widest and the most exact. They were few and weak where that relation was nonexistent or ineffective. But of course until real democracy began to assert itself there were no schools save the exclusive ones provided by the crown and church. With the approach of the Revolution and resulting from the same causes new social, ecclesiastical and political conditions produced a new order of schools. The tendency toward the independence of governmental and ecclesiastical affairs was developing and the close relation between church and state which so long obtained in the Puritan theocracy was weakening. The effect upon the schools was twofold,—to make the lower grades of schools the instruments of the democratic advance and to stimulate private and denominational effort in the interest of the old order. The results were the common elementary school, developed more slowly than we are accustomed to think, and also a new institution of much higher grade under private and denominational control, with more exact legal and corporate organization and powers, and not entirely without state largess. The grammar schools did not wholly disappear, but they rapidly decreased in numbers; and such as lived contracted their curriculums, and shed their denominational bent. A very few,

notably the Boston Latin School, have been adopted by the public and have come down to the present day, retaining a distinct classical curriculum. Wherever this has occurred it has been in close association with other secondary schools with wider courses and freer electives.

Even before the Revolution an academy appeared here and there: but it needed Independence to settle matters. And Independence did settle matters. We too often forget that there were two English parties on the other side in the American Revolution. The Puritan party was not a democratic institution, but it was being trained to more liberal and independent thinking, and was coming to see the need or at least the inevitable advance of democratic institutions. The English in America who had not yet become full-fledged Americans were Puritans. They had no deep affection for the Cavaliers or the Royal Cabal at London and their political and religious faith and their pioneer life made them the best fighters the world ever saw. Real separation made complete independents and pretty fair democrats of them all. They were a little slow and needed time, but time made them about the best Americans in the lot. They joined the issue and got up splendid little scrimmages at Lexington and Concord. They did some awful fighting at Bunker Hill, but lost the hill. They were not without humor, grim as it was, when they told the British commander they would like to sell him some more hills at the same cost. But the military power of the Cavalier political cabal for the time being in the control of the English government was outwitted on Long Island and pretty largely absorbed at Saratoga. It is interesting to hear Sir George Trevelyan, a good enough English authority, in the best and most judicial history of the Revolutionary struggle which has been written, tell us that we were then fighting the English government in order to keep and enlarge English liberty. Whether or not it would have otherwise been lost, as a matter of fact we did keep it and enlarge it. Under rather bad treatment after the war, which we all regret now, the Royalists either came to be Americans or went back to England or over to Canada and left a pure democracy to begin to break out new roads and go ahead as fast as it would.

The elimination of the influence of English politics from the affairs of government in America, the removal of the oversight of the English church over religious affairs in this country, and particularly the distinct enunciation of the entire separation of state and church in the scheme of government which rose above the fires

of the Revolution gave decisive impulse to new educational ideas and distinct form and energy to a new manner of school.

The American academy was not a democratic institution but it was more democratic than the colleges and Latin schools which antedated it. It was as democratic as the hold-over influences or the uncertain political theories of the time would permit it to be. It had an independent legal organization with an independent though perhaps a slender endowment and a self-perpetuating control. If it aimed to prepare pupils for college it undertook even more to prepare pupils for life when they were not going to college. Often its work was wider than that of the college itself. It laid new stress on the study of English, including its grammar, rhetoric and the art of public speaking. It went more broadly into mathematics, including surveying and navigation and it made important beginnings in the natural sciences. Chemistry and physics were favorite subjects. History was universally taught. Even architecture and stenography got a start. French was very common and German appears occasionally. If Latin and Greek continued to be upheld they were paralleled by innumerable courses which were clearly enough of democratic origin and must surely change the outlook of communities and propagate the democratic principle in affairs. It was attached to the fortunes of no party in politics, and although it was devoutly religious in spirit, it of necessity came to serve a constituency which was much broader than the membership of any single church. It exacted fees, but commonly far below the measure of its necessities, and its democratic tendencies disposed it to help all it could. It surely needed the aid which the state was disposed to give and as the state was a democratic one the fact stimulated the democracy of the academy itself.

The New York academies

By the act of Ap. 13, 1787, the Board of Regents of the University of the State of New York was given the power to charter academies. At the first subsequent meeting Erasmus Hall Academy, now Erasmus Hall High School of Brooklyn, was chartered. At the next meeting Clinton Academy at East Hampton in Suffolk county was chartered. In 1794 there were 12 of these academies, in 1809 there were 30, in 1829, 48, and in 1834, 64.

It has been the policy of New York, practically from the beginning to give aid and encouragement to secondary education. When the elementary school system was developed the state undertook to assure a primary school education to every citizen. It would not sup-

port it but has always compelled every district to maintain an elementary school and has made the stronger districts aid the weaker ones. It has never gone so far as to assure a secondary school to every community by requiring town or districts to maintain them, but it has gone far to induce communities to establish them by giving substantial aid to such as were established.

In 1790 the state established what is known as the literature fund by authorizing the Regents to take possession of certain state lands and apply the rents and profits to aid colleges and academies. In 1813 and again in 1819 the income of funds received from other state lands were added to the literature fund and in 1827 securities to the value of $150,000 belonging to the canal fund were added to it. Subsequent legislation transferred annually $28,000 from the United States deposit fund to the literature fund.

For convenient reference and because always interesting I insert here a table showing the distribution of the literature fund to academies in the years 1820, 1830, 1840 and 1860, which will indicate the number of schools, the whole number of pupils, the number of academic pupils, the sums apportioned, and the average amount to each academy. It is as follows:

	1820	1830	1840	1860
Number of schools	30	58	118	160
Number of scholars	2 218	4 303	10 881	28 941
Number of academic scholars	636	2 222	8 841	16 514
Amount apportioned	$2 500	$10 000	$40 000	$40 000
Average amount to each	$83	$172	$339	$250

To indicate the location and strength of the academies I insert a table giving the names of the academies, the amount distributed to each from the literature fund, and the number of pupils in each institution, by Senate districts in the year 1834, just seventy years ago.

FIRST SENATORIAL DISTRICT

Names	No. of students	Am't from literature fund
Clinton, Easthampton	46	$ 96 65
Erasmus Hall, Flatbush	95	280 70
Institution for Deaf and Dumb, New York	137	630 35
Oyster Bay, Oyster Bay	48	179 40
Union Hall, Jamaica	96	312 90
	422	$1 500 ..

SECOND SENATORIAL DISTRICT

Names	No. of students	Am't from literature fund
Delaware, Delhi	48	$ 43 54
Dutchess, Poughkeepsie	114	309 65
Farmers Hall, Goshen	34	87 08
Kingston, Kingston	60	111 27
Montgomery, Montgomery	63	212 91
Mt Pleasant, Mt Pleasant	147	246 97
Newburgh, Newburgh	72	309 65
North Salem, North Salem	35	72 57
Redhook, Redhook	36	106 36
	609	$1 500 ..

THIRD SENATORIAL DISTRICT

Albany, Albany	226	$278 80
Albany Female, Albany	318	470 08
Albany Female Seminary, Albany	150	197 45
Hudson, Hudson	61	132 30
Jefferson, Jefferson	50	42 80
Kinderhook, Kinderhook	75	140 41
Lansingburg, Lansingburg	21	34 66
Schenectady, Schenectady	182	203 50
	1083	$1 500 ..

FOURTH SENATORIAL DISTRICT

Cambridge, Cambridge	41	$ 98 51
Canajoharie, Canajoharie	57	197 02
Franklin, Malone	45	147 77
Gouverneur, Gouverneur	57	205 95
Granville, North Granville	61	80 60
Johnstown, Johnstown	49	80 60
Plattsburg, Plattsburg	42	111 93
St Lawrence, Potsdam	98	291 05
Washington, Salem	67	286 97
	487	$1 500 ..

FIFTH SENATORIAL DISTRICT

Names	No. of students	Am't from literature fund
Bridgewater, Bridgewater	52	$56 52
Clinton Grammar School, Clinton	25	31 10
Fairfield, Fairfield	77	118 50
Hamilton, Hamilton	83	198 65
Lowville, Lowville	71	69 26
Oneida Institute, Whitesboro	82	198 48
Rensselaer, Oswego, Mexico	47	105 73
Sem'y of O. and G. Conference, Cazenovia	263	319 ..
Union, Belleville	50	83 85
Utica, Utica	120	195 06
Whitesboro, Whitesboro	85	123 95
	946	$1 500 ..

SIXTH SENATORIAL DISTRICT

Cherry Valley, Cherry Valley	69	$207 20
Cortland, Homer	146	551 05
Franklin, Pittsburg	44	182 33
Hartwick, Hartwick	37	145 03
Ithaca, Ithaca	48	53 87
Oxford, Oxford	82	227 92
Owego, Owego	89	132 60
	515	$1 500 ..

SEVENTH SENATORIAL DISTRICT

Auburn, Auburn	85	$209 55
Canandaigua, Canandaigua	125	199 55
Cayuga, Aurora	39	119 71
Onondaga, Onondaga Valley	40	56 52
Ontario Female Seminary, Canandaigua	127	289 25
Ovid, Ovid	88	113 08
Palmyra, Palmyra	99	269 45
Pompey, Pompey	28	36 58
Yates county, Penn Yan	150	206 21
	781	$1 500 ..

EIGHTH SENATORIAL DISTRICT

Names	No. of students	Am't from literature fund
Fredonia, Fredonia	81	$279 62
Lewiston, Lewiston	57	204 02
Livingston county, Genesee	37	75 60
Middlebury, Middlebury	107	241 82
Rochester, Rochester	160	513 78
Springville, Springville	45	185 16
	487	$1 500 ..

The whole number of students reported in academies in 1834 was 5330 and the number allowed by Regents in the distribution of the literature fund, as having pursued the requisite studies was 3741; the value of academy lots and buildings was $390,825; value of other real estate, $19,722; the value of philosophical apparatus and library, $21,795; the value of other personal estate, $139,130; number of books in libraries, 10,145; tuition money for the year, $73,472; income from permanent funds, $9,275; amount received from the state, $12,000; debts due by academies, $72,137; number of teachers, 217; compensation of teachers, $68,924.

A study of the subject makes it clear that the Regents were discriminating in granting charters. They required satisfactory proof that the institution had sufficient means to support life and perform its work creditably and they saw to it that it was not likely to flourish at the expense of a previously incorporated institution. This led to applications to the Legislature which were often granted with less care. Between 1819 and 1830 there were more than 40 academic charters granted by the Legislature mostly without conditions. Upon the whole however it may be said that the academies of the state had an excellent and in many instances even an illustrious history.

But in time these splendid institutions were forced to give way to another class of institutions more democratic than themselves. About 375 academies were incorporated between 1787 and 1884. By 1884 very nearly 50 had been merged in union schools or had become separate high schools; four or five had been resolved into state normal schools, three or four had served as college foundations and about 250 had become extinct. A few after being chartered were never organized. There are now about 30 of the old time private or denominational incorporated academies still in existence.

During the last 20 years there have however come under the visitation and inspection of the Regents a large number of modern denominational schools of academic grade which more than makes good the number of academies reporting in 1884. But the public high schools have come to far outnumber them.

The high school movement

The academies were the outcome of the best thinking of almost a century of American progress. They were the embodiment of as fine heroisms as ever found expression in any educational institution and there have been no finer in the world. They were as democratic as the most aggressive democratic spirit of their day could make them. They did a work entitling them to enduring gratitude because of wide and permanent value. Then as a prevailing class they were forced aside by a new class of institutions which sprang out of fresh and advancing thought, were more democratic, met a wholesome and imperative demand for a wider range of work, had a much wider and more potential influence, and gained new and very different ends.

The academy was an incorporated and endowed institution, though commonly so slenderly endowed as to be transitory. The public high school is supported by taxation, managed by public officers and more independent and permanent. The high school is free; the academy was as free as it could be, but it lived largely upon fees. The difference appeared in the pupils, in the instruction, in the outlook, and in the measure of stability. The interest of the mass is the best endowment an institution can have. It is even more steadfast than statutes. The taxing power is not so spasmodic as beneficence.

The work of the academy connected with the colleges and had no organic connections below; that of the high school connects with the public elementary schools below and forces the colleges after long centuries of opposing theories to establish relations with the upper end of their courses or waive the hope of preeminence.

The academy was pushed down into unoccupied territory from above; the high school was pushed up into the same field from below. The business of one was to serve the interests that were above but not quite altogether heavenly; that of the other was to help on the broader and more worldly concerns that were below. In time it transpired that with all this in the same territory there was now and then some abrasion.

The function of the academy was to prepare for college and incidentally for life; that of the high school is to prepare for life and incidentally for college. The one was classical with some practicalities; the other is severely practical, and generally in the best sense, with some classical appurtenances. The academy was essentially an advanced school for boys; the high school is as essentially coeducational.

The courses of the high schools have widened out from the old standbys and gone into about everything that can aid one to earn a living. There is mental discipline in study that informs the mind and applies to life.

It is interesting to study the first decisive manifestations of this high school movement. They came in the West—in what was then the West—where there was nothing in the way, where democracy was freer than in thoroughly settled social conditions, and where the masses were doing things on their own account. The movement advanced on lines of least resistance, but when forced it accepted the gauge of battle, and when it did it won or drove a mutually advantageous compromise.

The movement from the beginning and always has been strong in the West—in whatever came to be the West. A western village is ashamed to be without a high school. The building is the finest and the most conspicuous in the settlement. It is so in all of the North Central, the Mountain and the Pacific states. Of course it results in many struggling high schools, but in many more which are as fine as any in the land. And moreover they will abundantly take care of a splendid future.

They will do that not so much because of what they are, but because of their buoyant spirit and their universal popularity, because they are everywhere and grow steadily, and because of the relations in which they stand. There are sixteen grades in the free school system in the great West. The continuity of the system from the beginning of the kindergarten to the graduate school in the state university is perfect and the road is open. Certificates of work done in the school below admit to the school above without examination. The inadequacy of a written examination as a test of the knowledge and the power of pupils when the examination is set by strangers who have had no immediate connection with previous work seems to me obvious. The acceptance of certificates helps pupils to go to the university who would not go. It stimulates and steadies all of the schools below. It articulates the whole educational system and gives each part intelligent interest and pride in all the other parts.

It does not lower standards in the universities. The tests of university work are as severe and the degrees as exalted as anywhere in the country. Eastern universities try not to believe it but they will have to open their minds and modify their opinions.

And a further word might be dropped by way of a not over venturesome prophecy. The old line universities which have come to be great, may of course continue indefinitely upon old line policies with only very slight modifications. But unless they go farther in accepting, not quietly or stealthily, but openly and avowedly, the credentials of high schools of unquestioned standing, unless every one who has in himself the reasonable possibilities of doing their work has his free chance, unless they guard against letting snippery and second-hand culture give tone to their character and flavor to their doings there will be free public universities in some of these Eastern states before all of us die.

The demand of our democracy for free education to the very limits of human knowledge is aggressive. It has grown more aggressive through the success of the public high school movement, and as a result of the influence of high school graduates upon the sentiment of the country. It is going through the land. It is a demand which will have to be treated politely and negotiated with or there will be another issue, which ought to be avoided, between public and private institutions.

The figures concerning the high school movement are as interesting as any figures are likely to be. Commissioner Harris tells us that at the turning point of the last century there were but 11 high schools with progressive courses continuing from two to four years and covering advanced studies in foreign languages; mathematics, literature, natural science and history. In 1860 there were 44 of these schools; in 1870, 160; in 1880, 800; in 1890, 2526; in 1900, 6005. This remarkable growth has been decisive in every section of the country—the South by no means excepted, but it has at all times been specially noteworthy in the Mississippi Valley states.

The New York high schools

But the advance of the secondary schools in New York is of chief concern to us tonight. From the very beginning of statehood the bounty of the state has gone liberally to these schools; and the return has approved the policy and justified the investment.

What is known as the literature fund, as already stated, was established in aid of secondary education in 1790. The stream made a

fine start and it has gathered volume in its progress. It is but just to say that no other state has anything like such a record. The state appropriation now for this purpose is $350,000 annnually, which is apportioned on the basis of $100 to each teacher, not to exceed $250 for approved books and apparatus provided the school supplies a like amount, and a proportionate share of the balance on the basis of attendance of academic students.

The state appropriations from 1793 to 1904 were, according to my best information, $4,526,983.80. The total expenditures of the system has been $104,583,413. The following table will show the state aid and total expenditures for each of the last 35 years:

Year	State aid	Total expenditures
1869	$ 44 444 46	$ 779 315
1870	43 755 54	971 241
1871	44 552 46	1 075 716
1872	45 643 92	1 059 394
1873	133 433 32	987 151
1874	122 962 36	1 160 845
1875	43 000 ..	1 157 946
1876	43 000 ..	1 120 731
1877	43 000 ..	1 083 229
1878	44 424 37	1 069 880
1879	43 000 ..	1 019 192
1880	43 000 ..	1 013 780
1881	43 000 ..	1 020 586
1882	43 000 ..	1 146 451
1883	43 000 ..	1 235 016
1884	46 000 ..	1 385 120
1885	44 203 18	1 323 566
1886	44 852 23	1 338 048
1887	105 535 22	1 383 609
1888	105 803 98	1 645 961
1889	107 215 56	1 936 841
1890	107 559 77	2 341 956
1891	99 034 17	2 484 295
1892	105 796 53	2 760 399
1893	105 824 48	2 840 282
1894	96 853 94	3 304 703
1895	116 549 19	3 133 218
1896	211 989 13	3 560 802
1897	111 684 37	3 284 246

Year	State aid	Total expenditures
1898	$197 923 78	$3 729 913
1899	205 031 56	5 226 825
1900	249 351 90	6 096 375
1901	292 311 91	5 702 718
1902	309 539 14	6 627 708
1903	304 126 43	7 107 000
1904	312 358 29	8 111 369
	$4 092 761 19	$91 225 427

In 1822 the Legislature passed an act making the trustees of Farmer's Hall Academy in the village of Goshen, Orange county, trustees of the common school district when a majority of the taxable inhabitants of the district, should give their consent thereto. An act similar in all respects was passed in 1823 concerning the academy and the common school district at Oyster Bay in Suffolk county. Here was the nucleus of the union school movement.

The first use, certainly the first legal use, of the term "high school" in this state seems to have grown out of the combined, or larger, or the little more advanced school of the Lancasterian movement. In 1825 an act was passed by the Legislature incorporating the "High School Society of the City of New York" and in the next ten years a dozen other similar acts were passed. Governor DeWitt Clinton gave that movement and this legislation his warmest support. While the institutions here provided for were far from public high schools as we use the term they were quite clearly the first fruits of the public high school movement. And the charters of at least two or three of these institutions contained the first distinctly recognizable factors of the public high school for they consolidated school districts, they associated academies and elementary schools together under public management, and they combined classical instruction with instruction in the useful arts.

The act of 1853 contemplated such schools everywhere and for the election of boards of education for their management. These union schools were authorized when there was an academy in their district to make the same the academic department of the union schools upon the consent of the board of trustees of the academy. Thus the process of elimination and absorption went on, and the union schools with the resulting academic departments, and then the independently organized high schools, came to possess the land.

The present number of academies is as follows:

Academies (incorporated)	102
Senior academic schools	3
Middle "	12
Junior "	25
Special "	3
	145
Of high schools	
High schools	407
Senior high schools	56
Middle "	60
Junior "	128
Special "	4

In the state, during the decade 1890-1900, while the growth in enrolment in the common schools was 16%, the number of public secondary schools increased 140%; the number of academies (including denominational schools) 34%; the total net property of secondary schools and the number of secondary students more than 100%. In 1903, secondary schools reported 95,096 students and a total net property of $33,771,006.27, with expenditures for the year of $7,106,999.90, as follows: high school property, $14,400,278.45; high school expenditures, $5,007,055.02; academic property, $19,370,727.82; academy expenditures, $2,099,944.88.

New York and other states

We would like to know where we are in comparison with other states. The United States Bureau of Education gives us the following figures:

The population of the United States is estimated at 10.43 times that of New York. The number of secondary schools in the United States is 14.54 times the number in New York.

The population of New York is 2.57 times that of Massachusetts while the number of secondary schools in New York is but 1.72 times the number in Massachusetts.

The population of New York is 2.93 times the population of Indiana while the number of secondary schools in New York is only 1.09 times the number in Indiana.

The population of New York is 4.9 times the population of California but the number of secondary schools in New York is but 3.05 times the number in California.

Turning from the number of schools to the number of pupils we find that whereas the population of the United States was 10.43 times the population of New York, the secondary school pupils in the United States was but 8.33 times the number in New York.

The population of New York is 2.57 times that of Massachusetts and the number of secondary school pupils in New York is but 1.78 times the number in Massachusetts.

The population of New York is 2.93 times that of Indiana but the number of secondary pupils in New York is 2.55 times the number in Indiana.

The population of New York is 4.9 times the population of California and the number of pupils in New York secondary schools is 4.05 times the number in California secondary schools.

This shows that in the nation at large we have less than our proportion of secondary schools but more than our proportion of secondary pupils.

It shows that we have a less proportion of secondary schools and pupils than such states as Massachusetts, Indiana and California.

Where is the explanation ? It must be admitted, and to her honor, that Massachusetts is exceptional in the number and character of secondary schools. And it is probable, and to her honor again, that she does better than many of the rest of us in making reports to the Bureau of Education. But why should states like Indiana and California have more secondary schools and pupils than New York?

As already suggested the secondary school development has been exceptionally strong, as it was relatively very early, in all of the Western states but if they have really gone farther than we in getting up into the realm of advanced popular education we need to bestir ourselves.

I think there is an ample and not a farfetched explanation. It is in the fact that the greatest city of the continent is within our borders. The data show that other states having a very large city in proportion to their populations are also below the average as to the number of secondary schools and pupils. Take for example Rhode Island, with the city of Providence, Maryland with Baltimore, and Illinois with Chicago.

There are 176 times as many people, 250 times as many secondary schools and 156 times as many secondary pupils in the United States as in Rhode Island.

There are 65 times as many people, 92 times as many secondary schools and 98 times as many secondary pupils in the United States as in Maryland.

There are 15.6 times as many people in the United States, 19.7 times as many secondary schools and 14.9 times as many secondary pupils as in Illinois.

New York has 16.84 times the population of Rhode Island, 17.17 times the number of secondary schools, and 18.71 times the number of secondary pupils.

New York has 6.22 times the population of Maryland, 6.35 times the number of secondary schools, and 11.75 times the number of secondary pupils.

New York has 1.49 times the population of Illinois, 1.35 times the number of secondary schools, and 1.79 times the number of secondary pupils.

If the size of the cities and the bread question in congested populations affects the attendance upon secondary schools as we know it must, then there is ample explanation of the New York figures. Cumulative explanation appears in the fact that until a very recent period in the older city of New York (Manhattan and the Bronx) there were no public high schools. Happily the omission is now being remedied by the upbuilding of a number which promise to be as large and as excellent as are to be found in the world.

Incidentally, the secondary school attendance of the United States has doubled in thirteen years. In New York it has doubled in nine years.

Comparing the statistics supplied in the state reports of New York and Massachusetts it appears that the number of secondary schools in New York in 1903 (780) was 1.9 times the number in 1893 (410) and that the number of secondary pupils in 1903 (95,096) was 2.3 times the number in 1893 (41,799) while the number of secondary schools in Massachusetts in 1903 (311) was only .9 times the number in 1893 (341) and the number of secondary pupils in Massachusetts in 1903 (49,075) was 1.07 times the number in 1893 (45,941). In other words, the number of schools in Massachusetts by her own reports actually decreased in the decade and the number of pupils practically stood still, while in New York the number of schools practically doubled and the number of pupils considerably more than doubled notwithstanding that the ratio of increase in population was exactly the same in each state. And do not infer that I am lacking in respect for the work in Massachusetts. I am comparing with what has been believed to be the best secondary school state in the nation, unless it is our own, merely in order to do simple justice to a very great educational advance in the Empire State.

But there is more to be said, and perhaps it goes more exactly to the point of our inquiry and will make clearer the course of true wisdom.

Let us exclude the city of New York from the calculation and see where the rest of the state stands. By the last report of the Bureau of Education the number of secondary pupils to each 10,000 of population was in Massachusetts 16.25, in Connecticut it was 12.13, in Pennsylvania 7.91, in Ohio 13.31, in Indiana 12.90, in Iowa 15.45, in Minnesota 9.85, in California 12.92; while in the state of New York outside of the greater city it was 14.4. And it must not be forgotten that there are many very considerable cities and one large city in the state outside of the city of New York which enter into this calculation.

The distribution of secondary schools is very uniform throughout the state. The following table will show it by counties, and it will be observed that every county is represented.

Location of New York secondary schools

Counties	Number of schools
Albany	18
Allegany	15
Broome	9
Cattaraugus	22
Cayuga	10
Chautauqua	20
Chemung	6
Chenango	13
Clinton	9
Columbia	8
Cortland	6
Delaware	10
Dutchess	13
Erie	29
Essex	16
Franklin	10
Fulton	5
Genesee	11
Greene	8
Hamilton	1
Herkimer	12
Jefferson	22
Kings	13

Counties	Number of schools
Lewis	7
Livingston	10
Madison	21
Monroe	18
Montgomery	8
Nassau	15
New York	19
Niagara	9
Oneida	25
Onondaga	26
Ontario	11
Orange	21
Orleans	6
Oswego	14
Otsego	19
Putnam	6
Queens	7
Rensselaer	17
Richmond	2
Rockland	6
St Lawrence	24
Saratoga	11
Schenectady	2
Schoharie	6
Schuyler	3
Seneca	4
Steuben	21
Suffolk	24
Sullivan	5
Tioga	9
Tompkins	9
Ulster	8
Warren	7
Washington	13
Wayne	13
Westchester	27
Wyoming	9
Yates	5
	753

Some institutions embraced in the University, but for some delinquency on their part not receiving aid from the state in 1903, are included in the foregoing list.

Beyond this the state has entered upon the policy of making an allotment to the high schools for the tuition of pupils who may come from districts without high schools in order to equalize the state largess for secondary education to all of the people, and particularly to make sure of aiding the more aggressive pupils in the less fortunate districts. The appropriation for this each year equals more than half of the entire sum which the state appropriates annually for the encouragement of secondary education.

From this it is clear that neither the state government nor the people in their local communities have been indifferent or unintelligent in the upbuilding of secondary schools. Taking the whole state together, in spite of the fact that the hindrances to the diffusion of higher education augment with the size and particularly with the congestion of population, New York justifies the splendid commendation of the author of *The Making of the Middle Schools* to which I alluded at the beginning. If the special drawbacks which present themselves in the metropolis were to be eliminated the presentation would abundantly show not only the best organized system of secondary education developed on American soil as Professor Brown puts it, but it would show about as abundant and energetic and probably more evenly distributed provision for secondary instruction as will be found anywhere in the land.

I have felt warranted in pointing to the fact that the city of New York has somewhat vexed our educational statistics, but I must not omit to say that there is at the mouth of the Hudson the greatest problem in popular education and particularly in that of a secondary grade which appears in this country or in any country. We have only admiration for what that great city, and particularly its educational leaders, and more particularly still its great city superintendent, are doing now. None of us would separate the statistics or sever the fellowship. We remember the millions upon millions which the limitless wealth of that city has paid to promote popular education in all the rural districts and we expect that there will be millions more. There is something to give back. It is of quite as much value as the coin of the realm. It is encouragement and commendation; it is educational experience and fellowship; it is balance and steadying power which grows most abundantly among the grasses and in the woods; and it is support in the much abused and often the unjustly abused Legislature, without which, in spite of all

that is said about home rule, I am not sure but the city would be doomed.

But before passing from the city of New York it ought to be distinctly said that the rapidity of growth in the high schools located within the territory embraced by the boundaries of Greater New York since 1897 is altogether unprecedented in the history of education in this country. In 1897 the number of high school students was 2360, in 1904, 27,824—an increase of 1079%. Within the same period the number of teachers increased from 111 to 841 or 658%; the annual expenditures from $161,084 to $2,922,648 an increase of 1714%; value of grounds, buildings and equipment from $637,-245 to $5,761,004 an increase of 804%. Nor is this all. There are, in addition, five high school buildings in process of erection, the aggregate contract price of which is above $3,000,000.

The future

Now let us turn our faces to the future. A careful inquiry, with no purpose but the ascertainment of the truth, seems to make it clear that the people of this state have not been remiss in setting up secondary schools; that in the number of schools and of pupils we are above the average; that the advance in numbers in the last decade has been as remarkable as gratifying; that with the exception of New York city these schools are evenly distributed over the territory and are fairly representative of the population of the state and that in the city the evolution is now going forward as heroically and splendidly as it ever did anywhere. This is not saying that there is not room for more, or that what we have are not to be made stronger. We are to ascertain what will accomplish both of these ends.

We have been speaking of numbers rather than of excellence. There is no reason known to me for imputations upon the character of these schools. I should be surprised to learn, after all that has been said or done, of any proof that the average of buildings, of equipment, of teaching power and of work accomplished was not high. Yet I have seen enough of school work to know that it often happens that people who have very indifferent schools think that they have the very best because no one does them the service of telling them the truth. It would not be surprising if there are many schools registered for but a part of the high school course which make the serious mistake of being more ambitious for a high sounding name and for appearing to do a lot of work rather than

for occupying a minor place which is just as honorable if they will do what they may do just as well as it can be done. A school which is giving a 48 count diploma in less than four years and with indifferent facilities should not be allowed to think that it is doing it as well as it may be done. There is nothing to be said against and there is much to be said for starting schools before they are able to do four full years work, but there is everything to be said against a fifty cent piece having the effrontery to try to pass itself off for a dollar. There is a field here that can not be tilled by people who are but half informed about the best there is in high school work, or by people who are self-conceited, who lack courage, or whose most substantial gift is mere politeness. It costs me nothing to admit that the strictly technical and professional phases of this great subject lie outside of the field in which I can personally work to the best advantage, but I expect to sustain the experienced, surefooted and aggressive men and women who have that work in hand and to reinforce their number as far as law and opportunity will let me with the best that can be found in any part of the country.

It is far from well that schools should have more courses than capacity to do the work completely. It is infinitely better to do less and do it as well as it can be done. It seems idle to offer six month courses when the results must be so superficial that if the pupil goes to a college of standing he must be told that before he can make a fair start he must get out of his head what has been put in it, and if he does not go to college he is likely to be hopelessly misled about his knowledge of the subject for all time.

Much would be accomplished if a movement to standardize the work of the secondary schools in all parts of this state, which is now under serious discussion, could be successful. And if that could be identified with the standard for admission to college established by the College Entrance Examination Board of the Middle States and Maryland the need of state universities in the Eastern States will be less urgent and logical than it otherwise will be, while the advantages to the colleges will be very considerable and the placing of more exact values upon the work of all secondary schools will be more stimulating and steadying than we can now foresee.

Nothing has been said tonight about the system of examinations which has had much to do with the tone and flavor of our secondary schools. There is ground enough for saying that standing where we did a generation ago, between the New England states where secondary schools grew naturally out of conditions fixed by historic causes and the West which was bound to have everything that was

new, it was practically necessary that something should be found to stimulate local interest and enlarge state appropriations for the evolution of academic schools. It was found by my early instructor and life-long friend, Doctor David Murray, for many years Secretary of the Board of Regents, in the System of Regents examinations. It was a good and potential move. There are no reflections to be passed upon anything that has been done in connection with it now. But while a system which has been long in the growing is not to be ruthlessly disrupted we are not bound to leave our sandals at the door when we meet to talk about it. Some of us who are in a way responsible to the future are bound to speak about many details of it very often and there is reason for thinking that the new conditions which will surely open to an educational system which keeps marching will force many thorough and discriminating discussions of it in the ensuing years. Let us have them without apprehension and without acrimony, with knowledge that temperate but truthful discussion is the life current of educational progress.

In the meantime one thing is entirely clear, and that is that when a scheme of examinations is practically decisive of the quality and of the course of a system of schools, that scheme in all of its branches, in all of its vital parts is bound to be not in second class or seventh class, but in educational hands of the very first class training, experience and rank.

Massachusetts makes, as she has always made, secondary schools compulsory by statute, though I am unaware how far the statute has been executed against a reluctant community. Not until recent years has the state appropriated state funds for the support of these schools. New York has required an elementary school of at least reasonable character within reach of every home. It has tried to assure the quality of the teaching by keeping in its own hands the certification of teachers while in our excellent sister state to the East that has been left to the same local authority which employed the teachers. After doing as much as that, and it has been very much, our state has left all the rest, including the secondary schools, to community initiative and local pride. We have stirred local initiative by favoring legislation, and we have done what reasonably might be done through the liberal distribution of state moneys to give education in every town and hamlet in the state the advantages which the stronger and wealthier communities owed to it. We have compelled in nothing save that there shall be a suitable building and a qualified teacher for a common elementary school. To that

extent, we expect to maintain a compulsion which compels. Beyond that we encourage and aid and then give to every community the satisfaction which must flow from its own accomplishments.

Our plan has prevailed from the beginning of our educational history and it prevails nearly everywhere in the country. Under it we have as excellent schools, both primary and secondary, as we would have had under a more mandatory system of legislation, while we have an educational system which is altogether unique in its flexibility and adaptiveness to all local conditions as well as in the stimulus which gives to the intellectual self-activity of a community and to willing popular support because of free popular proprietorship.

Now and again it has been proposed that we shall adopt some compulsory policies which will assure the universality of the secondary schools. Any step in that direction would be necessarily disturbing in the affairs of a system now grown great and in my judgment would remove from it its finest flavor and the features which make for its best efficiency. It should not be done unless necessary, and the necessity is not apparent. A secondary school is not necessary to safe citizenship. It may or it may not be necessary to the child's best chance in the world. That depends upon conditions. I can conceive of conditions in which compulsory attendance upon a secondary school might be what I would think an interference with the right of the parent and the best interest of the child. Whether or not that is conclusive of the question as one of policy it is conclusive of it as one of principle. Going on just as we are we shall have secondary schools quite as universal as they can be useful, and wherever they are they will stir the pride and hold the affections of a people.

New York recently began in paying from the state treasury $20 per year for the tuition of each nonresident pupil attending an established high school, a policy which proves her intelligent interest in a great subject and may easily be the instrument of very great results. But it seems to me that this movement needs some guidance to the end that it may do the most good, indeed that it may do more good than harm. Very possibly the legislation has not yet reached its final form and it needs generous and unselfish treatment to the end that its enduring state may be free from danger and full of good. I am confident you will agree with me in these propositions.

1 The point of this legislation is not to aid established high schools. That is done otherwise and very amply. If not sufficiently the remedy is upon application alleging the fact and by legislation which avows the purpose.

2 The state has not intended to change its thoroughly established policy of only encouraging secondary instruction. It has not begun the policy of wholly providing such instruction without cost to pupils in districts without high schools. If it had, the logical result would be absolute state support of all high schools, which would be mistaken if not absurd.

3 The point of this movement is to aid deserving pupils in nonhigh school districts, through equalizing to them the advantages which state appropriations now give to pupils in high school districts.

4 The state must not make it to the interest of a district without a high school to refrain from establishing one. It must not set up a policy which would develop great secondary schools, really small colleges, at central points by taking away the strength of existing schools in smaller places or at the cost of preventing additional schools.

5 The state ought not to put upon existing schools the burden of instructing nonresident pupils at much less than actual cost and ought not to encourage boards and principals to do this, in the interest of the mere largeness or prominence of schools.

6 The movement should have in mind, not one interest as against another, but every educational interest of the state. It must aid the weaker district and the specially deserving youth. The new stream of financial support must be made to help the interests of secondary education not where it needs no help, but where it really needs help, and most where it needs most help, and particularly to help boys and girls who will not get help without it. And it must be done so that the particular help afforded will not injure general or continuing interests.

Without any wholly confident judgment as to next steps in this connection, the foregoing propositions seem sound and it is not certain that the existing legislation exactly squares with them. But time and discussion will point the way for us. We have never yet been unable to put an appropriation where it would do the most good and we are not likely to be derelict now.

The secondary schools and the certification of teachers

The recent determination to accept the standings gained in the secondary schools for admission to the teaching profession affords an added reason, if any were needed, for universal interest in these schools, for giving the best attention to their affairs and for standardizing their work with the closest exactness. The fact illustrates, if it does not measure, the advantages of the educational unification movement in the state.

Secondary schools and district schools under same supervision

Let me add that I have been giving considerable thought to the interests of the country schools and I am impressed with the belief, which I have heretofore expressed to the State Association of School Commissioners, that those schools would be much benefited if they and the union schools and the town secondary schools could be actually related to each other in the same supervisory district. A like advantage would accrue to the higher schools.

I am not unaware that under the law they are commonly in the same supervisory district now. But it is more a legal fiction than an actual fact. The manner in which school commissioners are chosen and the entire absence of statutory requirements or accepted understanding as to qualifications, results in the election of many commissioners who have aptness for public affairs but who can not be actually accepted as superintendents of the technical affairs of the larger and higher schools. To say that this is always so would of course be unjust but that it is widely so will not be denied. I shall be wholly within the limits of truth if I go farther and add that in many a whole county taken together there is no actual supervision of the rural schools and we all know well enough that schools are not likely to get on as well without it as with it.

The fact that it would be impossible of success if there were not an even stronger reason, as there is, is enough to make any movement to abolish the district system uninviting. It is hardly worth while to entertain ourselves with things that can not be done or ought not to be done. But a movement to relate the secondary schools with the elementary schools in a unit of supervision which is small enough to make supervision possible, and under a superintendent who can superintend the largest and the highest as well as the smallest and the weakest to their advantage is possible of attainment and would be beneficent in its consequences.

Kindly give this matter the benefit of your reflections as it may quite possibly be a subject of future discussion.

Training teachers for secondary schools

The unprecedented growth of our secondary schools has created a demand for teachers of advanced work which it has been difficult to meet. The graduations from college are more than ever before but high schools want a large proportion of men teachers and the number of thoroughly prepared men who want to teach is small. Boys who have been taught by women all through the elementary

grades must at least hear a masculine voice and get things from a man's point of view by the time they get into the high school.

But the difficulty is rather deeper than that not many men incline to teaching. The work of the colleges does not incline them. Other callings seem more inviting and the colleges do but little by way of corrective. The colleges do not take much stock in educational theory about the professional training of teachers. College managements are more worldly wise than they used to be. So they nod to this theory in a polite way rather than lose any practical advantage which might result from ignoring it. But such interest as most of them take in it comes from prudence rather than conviction. And it must be admitted that when a university does establish a separate department upon the theory that education is a science and teaching a profession, unless it makes a separate school with considerable autonomy of its own, it finds difficulty in securing professors who can justify the theory and stir the efforts of ambitious men students. Yet, you and I know that one can hardly hope to become a successful teacher without deep study of educational history, theory and practice.

But if one can not teach without knowing how to teach he surely can not teach without knowing the subject he is to teach. The courses in the state normal schools (excepting the State Normal College) are not broad enough in subject-matter to prepare for teaching in the secondary schools and it seems to me can not be made so without an unwarrantable expense and the probability of lessening the attendance and withdrawing their direct and imperative aid to the elementary schools.

Now I have no doubt about the need of college bred men and women, with a good proportion of men, who have been prepared to teach, for the work of the secondary schools. We are not getting a sufficient supply. There is an hiatus in the educational system. The academies have rather the better of this because of their independent self-control, because of their somewhat greater exclusiveness, and because of their closer college connections. The high schools are suffering. It is time to do something; and the something might as well be decisive. Why not set a date when no teacher without an approved college degree shall be newly appointed in any secondary school while the school shares in state appropriations?

This would help the high schools most decisively. And it would do much more. It would help the colleges to a really serious appreciation of their responsibility for the plane of work in the secondary schools; and it would accentuate and vitalize the college influence in the educational system and in all the intellectual life of the state.

This state has been splendidly aggressive in uplifting the learned professions. It is no reflection upon any other work of recent years in the Regents office to say that the best things done have been the development of additional secondary schools and the closing of the doors to the learned professions against persons who are not learned. Not one whit of anything accomplished is to be lost. All we have gained we are to hold and more. There is to be no slacking of the pace. But let us be specific. In view of the high ground gained for all of the other professions it ought not to be difficult to do as much for the teaching profession. It is an absurdity to protect the other professions and neglect the most important teaching positions. The truth is we are, relatively speaking, protecting against incompetency in the elementary schools, even the little ones at the cross-roads, more than in the highest and largest schools we have, if I except certain cities where special or local laws apply.

The educational system must balance. The work in the upper schools is the hope of all the schools below them. There must be universal recognition of the worth of scholarship—not merely of its form or its pretensions, but of its juices and its flavor, and of its power to apply itself to the real concerns of life. Where shall this be if not in the schools? surely where, if not in the policies of an ambitious state system of education?

It will be unfair to accept this as a general imputation against the teachers of our middle schools. They have met the demands of their day. They have carried us over a transition period in the evolution of a great system. They are in most cases better prepared to serve us still than other or younger teachers can be. No criticism upon them and nothing but compliment for them is intended. They brought all that they could get into their work and it was much. They have supplemented it with experience and study. Nothing more could be asked of them. Nothing shall be done which could reflect upon them now. But we are facing new conditions and a new outlook. We must provide for an opening era. And we must make that era as great as we can through the sagacity of our plans and the abundance and forehandedness of our provision for it.

Conclusion

I must thank you for your patience, as I do very warmly, and speak my concluding word. The educational territory between the elementary schools and the colleges has come to be well occupied and it will be as completely occupied as it is possible for occupancy to serve the ends of a free people. This educational territory is

historic,—as engaging as the middle ground which stretches through the valleys of the Hudson and the Mohawk is enticing in the fascinating story of the Revolution. Upon this ground educational exclusiveness has met the democratic intellectual advance and been overwhelmed by it. Private schools will continue to command endowments of money and zeal and faith, and probably more liberal ones than heretofore; they will continue to serve constitutents who prefer some educational exclusiveness and they shall have our fellowship and support in the doing of it. But by far the greater number, and all supported by taxation, will train for life as well as for college, will express the purposes of the multitude, and be alined with the peoples' system of common schools. Upon that point the summing up is finished and the verdict is in. So far as conditions give rise to the demand the doors of the secondary schools will have to swing free to all the children of the state. The common schools are going higher. A universal system of free education is coalescing. The spectacle is inspiring. The readjustments may take time but when realized they will be potential because voluntary, energizing and uplifting because the natural product of a free people's thinking.

Thursday morning, December 29

GENERAL SESSION

THE DEVELOPMENT OF OLD THEORIES IN MOLECULAR PHYSICS FROM CORPUSCLES TO ELECTRONS

BY J. S. SHEARER, CORNELL UNIVERSITY

Speculation regarding the constitution of the material universe has played an important role in human thought for centuries. In fact we have no record of its beginnings, as tales of wars and rumors of wars were early regarded of greater interest than the physical universe, while the worship of idols, symbolizing the terrible powers that governed man's destiny was thought to be a surer way of securing satisfactory relations with physical environment than the study of actual phenomena.

One of the first to leave us a record of his physical theories was Aristotle, who may be regarded as the founder of the atomic theory in which the characteristics of ponderable masses are to be explained by the behavior of the most minute particles. Aristotle regarded heat, for example, as made up of atoms mutually repulsive whereby expansion, fusion, vaporization and destruction were to be explained. Indeed there has ever been a peculiar attraction in the idea that in the behavior of the smallest portion of matter was to be sought the explanation of all physical phenomena.

Grassendi about 1600 again proposed a molecular idea of heat action and described the atom of cold as tetrahedral whereby the sensation of cooling was due to the pricking of the skin by the corners of these minute pyramids and the solidification of liquids was caused by the clogging of free molecular motion by such rough particles. So might be traced the development of theories of vision where corpuscles were projected with great velocity to or from the eye as well as other explanations of physical phenomena more or less fanciful but ingenious. A new explanation of light action came into consideration in the Middle Ages and gained considerable weight only to be rejected by Newton in favor of a corpuscular theory which he modified with great ingenuity to met the facts. While at present we may look on Newton's corpuscle as fantastic or impossible we must admit that modern speculation is coming closely in touch with many of his ideas. And his statement of atomic hypothesis may well bear quotation at the present time.

The smallest particles of matter may cohere by the strongest attraction and compose bigger particles of weaker virtue and many of these may cohere and compose bigger particles whose virtue is still weaker, and so on, for diverse successions until the procession ends in the biggest particles on which the operations in chemistry and the colors of natural bodies depend, and which by adhering compose bodies of sensible magnitude.

Note his concept of a relative increase of attractive force as the size of the particle decreased.

The development of chemistry as a science from the dreams of the alchemists soon gave a more definite form to the concept of the molecule and the atom. The former referring to the smallest portion of a given material capable of maintaining existence and exhibiting its characteristic properties, the atom being an indestructible element not capable of further division. Some were inclined to regard the atoms of what we at present classify as elementary substances as compounds or aggregations of smaller particles which might ultimately be of a single kind [Prout's hypothesis]. Then came the development of the molecular theory of heat and the kinetic theory of gases where we have in addition to the idea of the existence of a countless number of minute bodies making up an ordinary mass the concept of great vibrational activity. In the hands of Maxwell, Clausius, Meyer, Boltzman and others the kinetic theory of matter has been developed till it stands as a monument to human thought and serves to correlate a vast amount of knowledge in various fields. Still electricity and magnetism were only vaguely suspected of having any connection with atomic structure. Many hypotheses were put forward to explain electric phenomena as by action at a distance, by one or two fluids of strange and remarkable properties and recently a molecular theory of magnetism has served a very useful purpose.

The foundation for the more recent developments in atomic theory was laid by the illustrious Faraday in his formulation of the laws of electrolysis. Here for the first time we have a definite quantitative relation between electric quantity and atomic masses. According to Faraday, in a dilute solution of hydrochloric acid we have a separation of a molecule H Cl into two parts H and Cl each with an inherent electric charge. The transport of electricity, constituting an electric current, is to be regarded as accomplished by the actual movement of the charged bodies which were named *ions* or wanderers. Here for the first time appears the idea of an electric charge in some way attached to matter which acts as a carrier. The amount of matter involved in

the transfer of a given electric charge would depend on the mass with which the natural unit of charge was associated. Thus if $CuSO_4$ separated into Cu and SO_4 and current is considered as due to the transport of copper, for each atomic unit of electricity delivered an atom of Cu must be used, while in the case of $H_2\ SO_4$ separated into H_2 and SO_4 two atoms of hydrogen are needed if the SO_4 carries the same charge in each case. If then this mass is abandoned, where the current leaves the electrolyte two atoms of H will be left at the electrode to one of Cu for the same transfer of electric charge. But an atom of Cu has a combining mass of 65 so that if it required the same number of atomic carriers, the mass involved when copper is used would be 65 times as great as when hydrogen is used but since each Cu atom carries twice the load it will require $65 \div 2$ as great a mass of copper as of hydrogen. Hence the law that the mass of matter deposited by a unit of charge passing through an electrolyte is given by the mass of hydrogen needed for the same transfer multiplied by the atomic weight of the carrier divided by its valence. It is to be observed that not only does electricity appear in this law as associated with mass in a definite way but numeric values of atomic weight and valence attained by methods having no apparent relation to electric phenomena are found essential. If however we must have these + and — carriers separated, in order to make this transfer, and chemical affinity holds Cu and SO_4 united, how does the process originate? Whence comes the initial carriers even if we assume that electric forces will cause their production when once current is started? If all the freight cars in Chicago were locked to immovable masses how could grain be carried without first freeing the carriers. Clausius was the first to offer an answer to this by assuming that in a dilute solution of $H_2\ SO_4$ a certain number of molecules were split apart or dissociated into + and — ions even before any electromotive force is applied. On this view, owing to various causes as molecular collision etc., certain molecules would be broken up and a free + ion might shortly combine with a free — ion but others would be separated in the mean time so that on the average a considerable number of free carriers would be available much as divorces in a populous country would insure a certain number of divorcees ready to migrate or remarry. The application of an electromotive force to these charged wanderers or ions would tend to drive + and — in opposite directions. Note here an additional fundamental concept regarding a separation of minute masses into + and — charged bodies probably by some mechanical shock

or molecular interaction. The significance of Faraday's work was hardly appreciated till Helmholtz, with his wonderful sagacity, declared that it pointed to an atomic theory of electricity.

About 30 years ago Sir William Crookes studied the electric discharge through gases at reduced pressure and discovered such remarkable phenomena that he was led to postulate the existence of a fourth state of matter. The series of tubes before you have been exhausted to show the more prominent features observed by Crookes. At atmospheric pressure we have the well known sharp, bright, crackling discharge, in the first tube we have reddish streamers passing between electrodes much more widely separated. The next tube shows a marked change in that nearly the whole tube seems to be filled with a reddish light except in the immediate neighborhood of one electrode where we observe a bluish glow separated by a dark space from the red portion. Variations in this glow and the dark space are noted in the next tube while in the last two you note a beautiful greenish light whose brilliance and color depends on the nature of the glass envelop and the degree of exhaustion. While all acknowledged the beauty of the phenomena shown by Crookes and investigators were stimulated to vigorous effort in its study physicists were not inclined to accept his idea of bombardment by minute particles in explanation of the facts. Physical science had only just emerged from the conflict between the corpuscular and the wave theory of light and the apparent relegation of various corpuscular theories to the background inclined many careful thinkers to the belief that in a wave theory would be found the explanation of these striking phenomena.

Then came the discovery of various so called rays excited by discharge in vacuo of which little was heard by the general public till the world was startled by the announcement of Professor Roentgen, hardly 10 years ago, that rays existed *outside* the vacuum tube which were able to penetrate many substances opaque to light and by means of the fluorescence and photographic action which they excited could give us shadow views and pictures of our bones. From that time to this hardly a month has passed without the announcement of some kind of rays due to electric discharge, radio-activity or some other more or less obscure cause. In order to correlate and explain this endless variety of phenomena a striking feature of which was the production of remarkable effects through solid bodies attention was again directed to Crooke's idea of minute corpuscles projected with high velocity.

The concept of the atom based on chemical phenomena as the smallest portion of matter involved in chemical reactions seemed to imply that nothing smaller than the atom and having the property of inertia or mass could exist and nothing so fetters the imagination as a preconceived idea of the limits of things. Two experiments having a direct bearing on the various facts stated may be briefly noted. The tube which you see here has a small slit near one terminal and a screen extending diagonally through the tube covered with a substance which fluoresces under the influence of electric discharge in vacuo. When the static machine is in operation you may observe a luminous straight line extending from the slit to the opposite end of the tube. According to one concept this light is due to the influence of very short waves while the other view would assert that minute bodies are projected through the slit with great velocity which by impact on the screen caused the illumination. These particles would be the real carriers of electricity and such a stream should constitute an electric current. If the latter view is correct this stream should be deflected by a magnetic or electric field while no experiment has yet shown a similar action on a beam of light. Bringing now a strong magnet into the neighborhood of the tube you observe the curvature of this stream which varies with the strength and direction of the field. Compare this with the curved patch traced by a ball projected horizontally under the action of the force of gravitation. The same effect is produced by an electrostatic field clearly pointing toward the correctness of the corpuscular view. This curvature of path caused by a known field has been used to investigate the properties of the bodies transferring charge. The greater the charge on a carrier the greater the force tending to deflect it while the greater the inertia (mass) the smaller the deflection. In this way the ratio of the charge carried by a single particle to its mass has been determined.

It should be borne in mind that all our concepts of physical phenomena are based directly on the idea of mass which is primarily recognized by its resistance to the accelerating action of mechanical force. All our statements of physical laws imply this point of view and while we recognize differences in force actions as shown by chemical behavior it seems difficult to modify our views to such an extent as to imagine a still finer subdivision of matter than that indicated in chemical analysis. Yet the investigations of the last 10 years have shown the probability of the existence of concrete portions of matter only one one thousandth as large as the hydrogen atom and that these particles either act as carriers of

negative electricity or, perhaps, in the aggregate they constitute electricity; that these atoms named electrons (electric ions) are usually attached to ordinary mass atoms and the removal of the electron leaves the remainder of the mass, originally neutral as regards electricity, positively charged. Still more radical is the concept that in this case the mass of the electron depends on its velocity.

On this basis all electric current and discharge phenomena are to be regarded as manifestations of the actual movement of electrons with or without accompanying atoms or molecules of ordinary matter.

Let us look briefly at the evidence in favor of this view. If the electrons have the property of inertia (even though of very small mass) when moving with great velocity they would possess considerable kinetic energy and if brought to rest by impact should develop heat. We have here a small x-ray tube one electrode of which consists of a heavy platinum plate of such conductivity as to be able to carry a very large current without heating. The discharge from a powerful coil is passed through it and the platinum becomes almost white hot in an incredibly short time though the extremely thin wires leading to the tube show no signs of heating. This is exactly what we should expect if electrons are projected with very great velocity and impinge on the platinum. Measurements of the velocity of electrons show that when free from ordinary matter they may have a velocity comparable with that of light so that a corpuscular theory of light is not quite so absurd from that standpoint as some have believed.

Why then this variation in appearance in the vacuum tube discharge as more and more of the gross matter is removed? Imagine for a moment a long street from one end of which are hurried out small messenger boys with great speed and that the street is more or less densely filled with moving wagons 1000 or more times as large as these fleet footed carriers but each of which is attached to one or more of these hypothetical boys. The impact of the projected stream would tend to jar off some of the boys on the wagons who might then be impelled to move in the general stream direction and so some free messengers would reach the other end of the street. The change of impact or the average distance moved before collision would increase with the speed of the messengers and with a reduction in the number of obstacles, till when the street is nearly clear, some boys would run the entire length before stopping, others would strike the buildings on the sides. Imagine this tube filled with a gas whose molecules are the wagons and that the electrons are the

small boys. When considerable gas is present it is difficult for the electrons to pass. Imagine also that violent atomic vibration may cause light then, as the free path becomes greater there is a region near the cathode where few collisions occur and light would be observed only at some distance from the electrode. When a high vacuum is reached many of the corpuscles impinge directly on the walls of the tube causing fluorescence. It is interesting to note also that the charge of an electron is found to be identical with that carried by a univalent ion in electrolysis, or, valence is a direct property of the number of electrons associated with an ion.

If electric transfer is only accomplished by ions approximately free from ordinary matter, to which they tend to cling, how are they to be freed in sufficient numbers to accomplish the results observed? May we not suppose that in gas there are always certain free electrons as Clausius assumed dissociation in electrolytes. Any agency capable of causing violent electronic disturbance would then be able to set these free electrons into violent motion and to cause those attached to ordinary atoms to vibrate often vigorously enough to separate some of them from the atoms. Each rapidly moving electron would aid in rupturing the bonds between atoms and other electrons so that the number of free electrons would increase with great rapidity. Among the agencies capable of ionizing a gas may be mentioned x-rays, ultraviolet light, radio-active bodies and possibly high temperature. A single experiment will illustrate the action of ultraviolet light in this connection. We have here a gold leaf electroscope charged inductively by hard rubber. A powerful disruptive discharge may be passed between three iron terminals which you observe are connected to the large coil. Placing a thin plate of glass between the electroscope and the spark gap we see that the leaves show no indication of losing their charge while when the glass is removed they are discharged at once. Placing these crystals near the discharge you note a pale blue light developed in one (fluorite) while the other (willemite) shows a brilliant green with reddish patches; interposition of the glass destroys this effect completely. It has been shown that glass is opaque to ultraviolet light and also that this light is effective in the production of fluorescence. This and many other experiments point conclusively to these extremely short waves as the agent by which the electroscope is discharged or to the ionization of the gas.

Consider for a moment now the information regarding extremely small particles which has been secured by a great variety of indirect experiments. Taking 1 cubic centimeter of gas at 0° and a pressure

of one atmosphere we have approximately 4.10^{19} molecules and the mass of a molecule would vary with the nature of the gas from $.910^{-24}$ (H) to 20.10^{-24} (CO_2) grams. Their mean velocity under the above temperature and pressure conditions varies from 184,200 cm per second (H) to 39,200 cm per second (CO_2). It would require about 16,000,000 molecules in close array to make a body visible under the most powerful microscope. We can weigh about .00001 gram with a fine balance so that about 5.10^{17} molecules of CO_2 would be the smallest number possible to weigh. Taking the electron as 1/1000 the mass of the hydrogen atom and carrying a charge of approximately 32.10^{-10} electrostatic units may we not more clearly appreciate the difficulties met in the experimentation on the most minute bodies yet known? Observe the introduction of the electron as a distinct entity whose business is to carry electric charge.

How are molecules and electrons held together? What sort of arrangements, what sort of motions are they likely to have? Our solar system is made up of ponderous masses separated by what to us seem to be unthinkable spaces. Yet there may be beings to whom the entire system is only an atom and who look on all the telescope reveals as only a finite portion of matter. May we not aid our imagination by the use of forces under our control. Taking a small steel ball and placing it on this plate of glass in a strong magnetic field we see that it is subject to force action. Adding a second ball you note a repulsive force between them, a tendency to maintain a fixed distance apart. A third is added and we have a triangular arrangement, a fourth gives approximately a square, five a pentagon, six a hexagon. Forcing two nearly into contact they attract instead of repel. Indeed, were we able to combine rapid vibrational motion with the force system shown we might approximate, with bodies of finite size the physical conditions among atoms.

Let us not forget however that the properties of the medium and the result of the aggregation of small bodies into finite masses must still be considered. The behavior of the oscillatory discharge in the circuit shown here may illustrate this point. Note the vigorous production of sparks and streamers while if a few more turns of wire (of negligible resistance) are added hardly any effect is produced. The circuit must be tuned by adjusting the capacity and self-induction in order to give the desired effects.

While we now recognize more clearly the value of corpuscular theories we need have no fear that belief in wave motion will be abandoned. In fact there is even greater need than ever before for the development of wave theory to clear up obscurities in various

fields. Are x-rays manifestations of movement of electrons or of even smaller bodies or are they due to waves so short as to differ in properties from light waves as these differ from electric waves miles in length?

The physicist may well be encouraged by the persistence of fundamental ideas and he should try to avoid hasty and injudicious disregard of any physical theory which has stood the test of experiment and which aids us in the explanation of a great variety of phenomena. A short time ago statements were freely made that radium violated the law of conservation of energy, and the American public always seems to be delighted with any suggestion of getting something for nothing. In the light of recent experiment and of such atomic structure as has been described the apparent supply of energy is only at the expense of a modified internal arrangement. New discoveries will be made from time to time, more careful investigation will indicate new relationship and call for modifications in physical theories, but the fundamental ideas of physical science, such as the conservation of energy, are likely to be found substantially correct through demanding a broader interpretation.

Let the teacher of physical science maintain an open mind, always receptive of new ideas, appreciative of new theories yet mindful that what has in the main proved to be in accord with past experience may yet explain what hasty inference would proclaim to be mysterious and unprecedented.

As we survey the field of attainment today, trying to put ourselves in the place of the great investigators groping in a world of mystery and realize that many of their thoughts are likely to stand the test of centuries of experience, let us hope that our generation may contribute to human knowledge something as worthy of a place in the history of science as was given by those who conceived the elements of molecular theory.

Reports of Committees

REPORT OF COMMITTEE ON ALCOHOL AND NARCOTICS

BY I. P. BISHOP, CHAIRMAN, BUFFALO NORMAL SCHOOL

As the result of a suggestion made by Mrs Cora D. Graham, President of the Woman's Christian Temperance Union of Onondaga county, in the course of an address delivered before this body at our last meeting it was moved and carried " that the several state educational organizations, the Woman's Christian Temperance Union and the New York State central committee, be requested to send delegates to confer with the Committee on Stimulants and Narcotics of the State Science Teachers Association to discuss means whereby the teaching in our schools of physiology, hygiene, and in relation to them the nature and effect of alcohol and other narcotics, may be rendered more efficient." This resolution was drawn up jointly by Mrs Graham and the chairman of the narcotics committee and approved by both. Early in January 1904 I sent a circular letter to the presidents of the organizations named, including copies of the resolution and requesting action on it. Six of the educational bodies named delegates. The New York central committee, however, and also the Woman's Christian Temperance Union declined to do so or to take part in the conference. Notwithstanding their refusal it was thought best to proceed with the conference which met yesterday [Dec. 28] at our headquarters. Five organizations were represented at the meeting. As the result of its deliberations the conference decided that more time would be necessary to perfect a plan of action. The members therefor voted to report progress and to ask that the members of the conference be continued for another year.

As the narcotics committee has completed the work for which it was originally formed I request that it be discharged.

Moved and carried, That the committee be discharged.

I. P. Bishop and James E. Peabody were appointed to represent the association at the next session of the conference.

REPORT OF COMMITTEE ON A SYLLABUS FOR SECOND YEAR PHYSICS IN HIGH SCHOOLS

BY ERNEST R. VON NARDROFF, ERASMUS HALL HIGH SCHOOL, CHAIRMAN

During the past year the syllabus as presented by the committee and indorsed by this association at the last meeting has been put into active operation in several high schools. Although a few weak points have come to light, the syllabus as a whole seems to work very satisfactorily. With the selection suggested in last year's report it does not seem too long. This is perhaps mainly due to the higher grade of pupils electing this course.

A plan is now on foot by which some ten of us will systematically exchange views as we continue to work out the course in our respective schools. It is hoped that by the end of the coming year our material will be mature enough to warrant publication, and that designs of apparatus will be ready for the manufacturers.

It is with much gratification that I observe the response of Columbia University to this movement. This university has established in its summer school our identical course, so that now any teacher desiring to introduce it into his school may become familiar with it with the least possible trouble.

The committee desires to be continued for another year for the purpose of perfecting its syllabus.

REPORT OF COMMITTEE ON LABORATORY COURSE IN PHYSIOLOGY

BY CHARLES NEWELL COBB, CHAIRMAN

The committee desired to receive comments from the members of the association after the distribution of the report of last year. Disappointed in this owing to the lateness of the publication of the report your committee reports progress and asks to be continued.

REPORT OF COMMITTEE ON THE SYLLABUS REVISION IN PHYSICS AND CHEMISTRY

BY GEORGE M. TURNER, MASTEN PARK HIGH SCHOOL, BUFFALO

The work in physics and chemistry in the secondary school may naturally fall under five heads: (1) topics for discussion, (2) demonstrations by the instructor, (3) individual laboratory work, (4) problems, (5) quizzes.

1 **Topics for discussion.** This term is intended to indicate the development of the subject together with the discussion of the subject-matter by the mutual aid of the instructor and pupils. Frequent lectures by the instructor are to be commended. The enlargement of the subject, by the discussions that call out the individuality of the pupil, are to be strongly encouraged.

2 **Demonstrations by the instructor.** As helpful as laboratory work is in bringing the pupil in touch with the apparatus and the manipulation of the same, this branch of the subject can not in any sense do away with demonstrations by the instructor. Not only are many helpful experiments impracticable for individual laboratory work, but are beyond the skill of the laboratory student. It is important that the instructor present this side of the subject with as much skill as possible in order to avoid unsatisfactory apologies for poor success.

3 **Individual laboratory work.** This side of the subject is each year receiving more careful consideration, as its importance to the pupil is the more recognized. It is therefore desirable that the work done should be definite in its nature, and with a clearly recognized aim in view.

4 **Problems.** It is necessary that mathematics should enter into any proper course in physics or chemistry, since the position of these subjects as sciences compels the utilization of measurements of definite masses and definite forces. It is however undesirable that problems be solved for their own sake. Their solution should merely serve to assist the pupil toward the better understanding of a principle. Problems required beyond this point lose their usefulness.

5 **Quizzes.** While the office of the teacher is clearly that of instruction, judicious use of pointed questions that tend to show to what extent the pupil has obtained, from a demonstration or a laboratory experiment, the desired ends, is to be strongly commended.

Your committee wishes it understood that the order of sequence in the arrangement of the above headings has no bearing on their relative importance. No one of these headings should be given a preeminent place over the others, but each should be subordinated to a logical plan of work.

General suggestions

It is urged:

a That much care be exercised by the instructor; that the laboratory equipment for any given period of work, be in the best possible condition, in order that delays, due to imperfect apparatus or lack of working material, may be reduced to a minimum.

b That the State Education Department allow no credit for a pupil's work in physics or chemistry unless the work embraces at least a certain minimum amount of laboratory training. (Further mention of this topic will be made later.)

c That notebooks, containing a true record of the pupil's work in the laboratory, be required of each laboratory student. Diagrams, that are properly proportioned to the apparatus used, should be expected.

d That credit for laboratory work be placed on some basis that will recognize relative merit and discourage poor work, thus eliminating the " time service " system. Such a system as suggested would employ a graded scale of credits, proportioning their allowance to the carefulness of the work done and the advancement made by the pupil in laboratory work.

e That no credit be given in either physics or chemistry for less work than that of a year's course in either subject. This would entirely do away with the present terms, part 1 and part 2, and the separate credit allowance for each.

f That when the high schools of the State have reached a certain standard of efficiency and equipment in physics and chemistry, the work of these schools, while subject to the counsel and inspection of the State Education Department may be regulated by the principal and instructor of the school, so far as the plan of work and the conduct of their own examinations is concerned. That the credentials of such schools be accepted by the State Education Department in a similar manner to that employed by many colleges, where the high school work of the student is accepted on the certificate of the instructor and principal of the approved school.

Courses

Your committee would recommend for the schools of the State the following courses in physics and chemistry:

1 **Physics**

Course A. A course adapted for a first year's work in the subject, by schools that are well equipped with apparatus and working appliances:

Course B. A course adapted for a second year's work in the subject by schools of the same grade as Course *A*.

Course C. A course, with abbreviated laboratory work, adapted for a first year's work in the subject, by schools that are less favorably equipped with apparatus and working appliances.

2 **Chemistry**

Course A. A course adapted for a first year's work in the subject, by schools that are well equipped with apparatus and working appliances.

Course B. A course, with abbreviated laboratory work, adapted for a first year's work in the subject, by schools that are less favorably equipped with apparatus and working appliances.

Physics Course A

The subject-matter of this course is intended to present to the pupil the foundation principles of the science, the applications of the same, coupled with suitable laboratory work to bring the pupil in close touch with the subject. It is recommended that the classroom work be confined to about the material outline in the accompanying syllabus. This course is intended not only as preparation for college entrance, but to give all pursuing it a good groundwork in physics. While the laboratory outline has many points in common with the requirements of the College Entrance Examination Board, and it is quite as easy to fit a pupil for college entrance from this outline as from the outline laid down by the College Entrance Examination Board, the committee believes that the course it recommends is better adapted for the schools of New York State than is the outline of the College Entrance Examination Board; (*a*) because the proposed outline does away with certain experiments that have been found by experience undesirable, and has substituted in their stead others of recognized merit; (*b*) because the proposed outline introduces a larger per cent of qualitative experiments than does that of the College Entrance Examination Board.

It is recommended that 40 experiments, selected from the following list, or 40 experiments similar in character to those of the following list, be regarded as a minimum requirement for this course. Of the experiments selected, it is advised that not more than 15 experiments be qualitative.

It will also be observed that your committee offers an outline of topics as a guide for discussions, demonstrations and applications. The College Entrance Examination Board *Requirements* presents no similar outline for the assistance of the instructor. It is expected and recommended that a school emphasize certain portions of the course, according as the equipment of the school or the industrial facilities of the locality may warrant, while lessening the amount of work on other portions of this course. In this manner the individuality of the instructor and the applications of the subject may best be utilized.

Physics Course B

It has for sometime seemed wise to the more progressive of our science instructors that a second year course in physics be offered the pupils of the better equipped secondary schools. It is the feeling of your committee that the time has arrived when such a course may advantageously be offered to the schools of this State. The second year course is not an untried experiment, but has found favor where put into use. The rapid growth of the subject-matter of physics in the last few years, the necessary increase in the time required of the pupil for laboratory work, have contributed toward the overcrowding of the physics work of the first year. It is for the purpose of properly presenting this work and strengthening the work of the first year that the second year course is proposed. It is not the intention of the committee that the course be made a compulsory one in any curriculum, but be made an optional subject for those pupils who have proved by their first year's work that they are fitted for and desire further work in the subject.

The course recommended below was submitted to and approved by the State Science Teachers Association, in all of its essentials, at its meeting in December 1903.

Physics Course C

Your committee recognizes the disadvantageous conditions under which many of the smaller and less favored schools and teachers work. It is their belief that no one course in physics can adequately satisfy the needs of all the schools under the control of the Regents. They also believe that no credit for work in physics should be given unless accompanied by a certain amount of laboratory work. Since the equipment of the school and the time allottment for laboratory work must of necessity be less in many schools than in others, we have prepared and would recommend, an abbreviated outline for

laboratory work that would seem to be within the limits of the schools working under the most unfavorable conditions. From the 62 experiments of Course *A* there have been selected 30 experiments that are simple of manipulation and require a minimum amount of apparatus. Accompanying this outline is to be found a list of apparatus that will meet the needs of all the 30 experiments. Prices on this apparatus, furnished by a reliable apparatus firm, indicate that for $10 a pupil the work of the 30 experiments may be accomplished. In sets of 6 or 12 the price may even be reduced to $9 or $8.50 a pupil. From the above it would seem that the most serious, if not all the objections to individual laboratory work in every school teaching physics, has been met and the State Education Department be justified in requiring a certain amount of laboratory work, if any credit is to be allowed for the subject.

It is recommended that 20 experiments selected from the following list, or 20 experiments similar in character to those of the following list, be regarded as a minimum requirement for this course. Of the experiments selected, it is advised that not more than one half the experiments be selected from that portion termed "Mechanics and Hydrostatics." While the remaining one half be selected from those portions termed "Light," "Heat," "Electricity and Magnetism." It may be proper to state that your committee did not make the selection of the experiments referred to, so much from pedagogic reasons as from the standpoint of simplicity of manipulation and low cost of the apparatus required.

It is intended that the topical work of this course follow the same general syllabus as that of Course *A*, but be less exacting, with naturally fewer demonstrations and practical industrial applications.

Chemistry Course A

The work presented by your committee for this course consists of a laboratory outline and a topical syllabus, as under physics course *A*.

The committee has departed much further from the laboratory outline of the College Entrance Examination Board in chemistry, than it did in the case of physics:—(*a*) because the outline of the College Entrance Examination Board does not follow the logical sequence accepted by the best instructors of chemistry and laid down in the most approved textbooks, as best calculated to the proper development of the subject for the mind of the beginner; (*b*) because several of the experiments, given in the above mentioned course, are not only impracticable for pupils of the secondary

schools, but in one or two cases unsafe in the hands of any but skilled experimenters; (*c*) because the proportion of the quantitative experiments to the qualitative experiments is too large.

The committee have endeavored in the outline presented: (*a*) to follow the accepted logical order of sequence, (*b*) to adopt this outline to a topical outline of the subject, (*c*) to introduce experiments of recognized merit, that are neither unsafe nor too difficult—in manipulation or interpretation of result, (*d*) to only introduce such a number of qualitative experiments as will lead the student to an appreciation of the exact side of the science. An examination of the outline will show that it is quite possible to select for college entrance a sufficient number of experiments that are satisfactory for the purpose.

It is recommended that 40 experiments, selected from the list which follows, or 40 experiments similar in character to those of the following list, be regarded as a minimum requirement for this course.

The topical syllabus, which is adapted to the outline so far as logical sequence is concerned, is intended as a guide for the development of the subject, for discussions and for industrial applications. Here, as under physics, it is urged that the instructor aid the concepts of the pupils by appropriate demonstrations as needed.

Chemistry Course B

In keeping with the plan outlined under physics course *C*, we would present an abbreviated outline in laboratory work, adapted to the needs of the schools that are enabled to spend but a minimum amount of time on laboratory work. In chemistry the cost of apparatus for individual work, when the experiments are not complex, is not so important a factor as under physics. It is assumed that the needs of such a course as outlined, is readily comprehended by the instructor and a special list of apparatus with prices is unnecessary.

It is recommended that 20 experiments selected from the list which follows, or 20 experiments similar in character to those of the following list, be regarded as a minimum requirement for this course.

It is intended that the topical work of this course follow the same general syllabus as that of Course *A*, but be less exacting, with naturally fewer demonstrations and fewer practical industrial applications.

Your committee wishes to make clear that the particular laboratory exercises, indicated for physics or chemistry, are not to be construed as excluding others of the same general character, or on the same or different topics of the syllabus, but are simply presented as well known exercises that be recommended. Improvement in laboratory exercises, by modified apparatus or changed plan of manipulation, is much to be encouraged.

PHYSICS

Topical syllabus

1 **Properties of matter and molecular physics**
Inertia
Mass, weight and volume (distinctions)
Structure of matter
States of matter (solid, liquid, gaseous)
Elasticity of form and volume
Tenacity (cohesion)
Surface tension
Capillarity

2 **Mechanics**
a Statics of liquids
Density (measuring and weighing)
Law of buoyancy
Specific gravity of solids heavier than water
Specific gravity of solids lighter than water
Specific gravity of liquids
Laws of liquid pressure (hydrostatic press)

b Statics of solids
Levers (moments)
Wheel and axle
Inclined plane
Screw (qualitatively)
Pulleys
Center of mass (equilibrium, stability)
Equilibrium of forces intersecting at a point (parallelogram of forces)
Work and rate of doing work (horse power, gravity units only)

c Statics of gases
Weight of air
Pressure of air (atmosphere)
Buoyancy of air (balloons)

Barometers (mercurial, aneroid)
Barometric variations
Siphon
Relation between volume and pressure (Boyle's law)
Pumps

d Dynamics

Motion (uniform and uniformly accelerated)
Law of motion
Law of falling bodies
Curvilinear motion (centripetal and centrifugal force)
Energy (potential and kinetic, qualitatively)
Pendulums. (Omit changes due to G.)

3 **Light**

Physical nature of light (velocity, extreme shortness of wave length)
Images (by small apertures)
Shadows
Reflection (plane mirror)
Reflection (concave mirror)
Reflexion (convex mirror)
Refraction (index, critical angle, total reflection)
Parallel plate and prism
Lenses (concave and convex)
Convex lens in simple microscope, eye, camera
Analysis and synthesis of white light
Color (transmission, reflection, pigments)

4 **Heat**

Nature of heat
Sources of heat
Thermometers
Expansion of solids (coefficient)
Expansion of liquids
Expansion of gases (law of Charles)
Conduction (liquids and solids)
Convection (gases and liquids)
Radiation (briefly)
Change of state
Boiling and evaporation
Cold by evaporation and solution
Dew-point
Latent heat of melting
Latent heat of vaporization

Specific heat
Steam engine (simple form)
Gas engine (simple form)

5 **Sound**

Vibration the source of sound
Sound waves (length and amplitude)
Velocity of sound
Sounding-boards
Various transmitters of sound
Reflection and echoes
Pitch (siren)
Vibration of strings (law of length)
Sympathetic resonance
Resonant quarter column
Overtones
Timbre
Interference of sound waves (beats)

6 **Magnetism**

Natural and artificial magnets (poles)
Substances attracted or repelled by a magnet
Compass needle (mutual action of poles)
Magnetic induction from magnets and earth
Magnetic lines of force
Theory of structure of a magnet

7 **Electricity**

a Chemical relations

Simple cell (local action, polarization)
Primary cells (gravity, Daniel, sal-ammoniac, dry)
Secondary cell (lead type)
Ohm's law
Laws of resistance (shunt)
Protection of wires (insulation)
Electromotive force and internal resistance of cells in groups (series, multiple)
Chemical effects of current (decomposition of water and solutions)
Electrotyping and electroplating

b Heat effects of current

Electric heating apparatus
Fuse wire cut-out
Incandescent lamp
Arc lamp

c Magnetic effects of current
Lines of force about a current
Effect of current on compass needle (galvanoscope)
Effect of helix (with and without iron core)
Electromagnet
Simple telegraph
Vibrating bell
Simple telephone
Simple motor
d Induction effects of current
Induced current in secondary coil by various changes in primary coil
Induced current by means of a magnet
Generators
Permanent field magnets—magneto
Temporary field magnets—dynamo
Direct current dynamo
Alternating current dynamo
Transformer
Induction coil
c High potential effects
Opposite electrification of two insulators rubbed together
Conductors and nonconductors
Gold leaf electroscope
Induced charges (electrophorus, Leyden jar)
Distribution of charges (surface)
Effect of points (lightning rods)
d Electrical measurements
Volt, ohm, ampere, watt, kilowatt-hour (henry)
Voltmeter, ammeter (use of instruments)
Resistance by substitution

Laboratory course A

Mechanics and hydrostatics

1 Measurement: metric system
2 Weight of unit volume of substance
3 Lifting effect of water on a body entirely immersed
4 Specific gravity of a solid body that will sink in water
5 Specific gravity of a block of wood by use of a sinker
6 Weight of water displaced by a floating body
7 Specific gravity of solid lighter than water by flotation method
8 Specific gravity of liquid: sp. gr. bottle

9 Specific gravity of liquid: displacement
10 Specific gravity of liquid: balancing columns
11 Gravity pressure of water: different depths, different directions
12 Straight lever: first class
13 Straight lever: second class
14 Straight lever: third class
15 Center of mass and weight of lever
16 Inclined plane
17 Pulleys
18 Three forces acting on a bar: moments
19 Three forces acting at a point: parallelogram of forces
20 Pendulum (omit work on *g*)
21 Compressibility of air: Boyle's law
22 Study of the siphon
23 Weight of a liter of air

Light

24 Image of point in plane mirror: law of reflection
25 Images in plane mirror
26 Mirrors at an angle: parallel mirrors
27 Images formed by convex mirror
28 Images formed by concave mirror: virtual image
29 Index of refraction of glass or water
30 Total reflection in glass
31 Path of ray of light through prism
32 Focal length of converging lens
33 Conjugate foci of converging lens
34 Relative size of image and object formed by converging lens
35 Virtual foci formed by converging lens
36 Use of photometer

Heat

37 Study of heating water to boiling
38 Testing a mercury thermometer, including effect of pressure, qualitatively
39 Determination of melting points: solids (paraffin, naphthalene, wax)
40 Determination of boiling points: liquids (wood alcohol, ordinary alcohol, acetone)
41 Determination of dew point
42 Linear expansion of a solid
43 Distillation. Purification of water

44 Evaporation: relative lowering of wet bulb thermometer by different liquids
45 Specific heat of solid
46 Latent heat of melting
47 Latent heat of vaporization

Sound

48 Velocity of sound in air
49 Length of resonant quarter column
50 Number of vibrations of tuning fork

Electricity and magnetism

51 Lines of force about a bar magnet
52 Study of single fluid cell
53 Study of lines of force about a galvanoscope
54 Making an electro magnet: polarity; lines of force by compass and by iron filings
55 Making a permanent magnet, by induction, by contact; polarity
56 Study of telegraph key and sounder
57 Study of vibrating bell
58 Study of induced currents
59 Study of telephone receiver and transmitter
60 Study of simple motor
61 Construction and study of simple lead plate storage cell
62 Resistance by substitution

Laboratory course B

The outline for work in this course will be found in the proceedings of this association for the year 1903. It is not thought wise to reprint the outline as a part of this report.

Laboratory course C

Mechanics and hydrostatics

1 Measurement: metric system
2 Weight of unit volume of substance
3 Lifting effect of water on a body entirely immersed
4 Specific gravity of a solid body that will sink in water
5 Specific gravity of a block of wood by use of a sinker
6 Weight of water displaced by a floating body
7 Specific gravity of solid lighter than water by flotation method
8 Specific gravity of liquid: sp. gr. bottle
9 Specific gravity of liquid: displacement
10 Straight lever: first class

11 Straight lever: second class
12 Straight lever: third class
13 Three forces acting on a bar: moments
14 Three forces acting at a point: parallelogram of forces
15 Pendulum (omit work on *g*)

Light

16 Image of point in plane mirror: law of reflection
17 Image in plane mirror
18 Mirrors at an angle: parallel mirrors
19 Index of refraction of glass
20 Focal length of converging lens
21 Relative size of image and object formed by converging lens

Heat

22 Study of heating water to boiling
23 Testing a mercury thermometer by boiling point of water and by melting point of ice
24 Determination of melting points: solids (paraffin, naphthalene, wax)
25 Evaporation: relative lowering of wet bulb thermometer by different liquids

Electricity and magnetism

26 Lines of force about a bar magnet
27 Study of single fluid cell
28 Making an electro magnet: lines of force by compass and by iron filings
29 Making a permanent magnet, by induction, by contact: polarity
30 Study of vibrating bell

Apparatus for laboratory course C[1]

1 meter stick
1 spring balance (250 grams)
1 overflow can
1 catch bucket
1 rectangular block (loaded)
1 rectangular block (not loaded)
1 battery jar (15 cm x 20 cm)
1 lead weight (for sinker)
1 loaded cylinder
1 rod (20 cm x 1 cm)

[1]The above mentioned apparatus can be purchased of any reliable apparatus firm for a sum not exceeding $10, and is sufficient for the work of one pupil in performing all the 30 experiments.

1 brass holder for rod
1 glass-stoppered bottle (50 c. cm)
1 lever and support
2 pans for lever
1 set iron weights (25 gr.-200 gr.)
2 lead balls (for pendulum)
2 plane mirrors (5 cm x 15 cm)
2 straightedge rulers (for sighting)
1 block (one side coated white, with black line)
1 glass plate (10 cm x 7 cm, polished edges)
1 pair school compasses
1 shaded lamp
1 protractor and square combined (cardboard)
1 double convex lens (10 cm or 15 cm focus)
1 lens holder
1 screen holder
1 flask (500 c. cm)
1 ring stand (2 rings)
1 burner (for alcohol or gas)
1 wire gauze (10 cm square)
1 thermometer (C. & F. graduations)
Small pieces of wax, paraffin, naphthalene
1 calorimeter
10 c. cm of each of the following: water, alcohol, ether
2 bar magnets
1 compass (2 cm needle)
100 grams iron filings
1 cylindric soft iron rod (15 cm x 1 cm)
1 simple cell (zinc, copper, glass)
50 grams sulphuric acid (com.)
1 sewing needle
1 knitting needle
1 vibrating bell
2 dry batteries or 2 sal-ammoniac cells

CHEMISTRY

Topical syllabus

Introduction

Chemical changes } comparison
Physical changes }
Illustrations to make clear chemical changes
Relation between chemistry and physics
Distinction between mechanical mixtures and chemical compounds

Nature of elements
Nature of compounds
Employment of symbols

The atmosphere—nitrogen
General properties of the atmosphere
Ingredients of the atmosphere
Approximate composition of the air
By volume
By weight
Variation of watery vapor and carbon dioxid in the air
Reasons for regarding air a mixture
Liquid air, preparation and properties
Nitrogen, preparation and properties
Relation of nitrogen to life

Oxygen
Occurrence
Preparation
From mercury oxid
From potassium chlorate
From mixture of potassium chlorate and manganese dioxid
Properties
Oxidation, oxidizing agents, oxids
Kindling temperature
Combustion, burning, decay
Relation of oxygen to life
Liquid oxygen—preparation and properties

Hydrogen
Occurrence
Preparation
Decomposition of acids by metals
Decomposition of water by electric current
Decomposition of water by metals, ordinary temperature
Decomposition of water by metals, elevated temperature
Properties
Industrial uses

Water
Occurrence
Properties
Natural waters
Pure water
Impure water
Sources of impurity
Methods of purification

Solution—gases, liquids, solids
  Saturated and supersaturated solutions
  Crystallization
Water of crystallization
  Efforescence and deliquescence
  Hydrated and dehydrated substances
Composition
  By volume
  By weight

Acids, bases and salts
General properties of acids, bases, salts
Neutralization
Definitions of acid, base, salt

Law and theory
Law of definite proportions by weight
Law of multiple proportions
Brief statement of atomic theory
Use of the terms: symbol, formula, equation, atomic weights, molecular weights

Light, heat, electricity, and chemical action
Light as cause and effect of chemical action
Heat as cause and effect of chemical action
  Industrial uses of the electric furnace, calcium carbid
    Carborundum
Electricity as cause and effect of chemical action
    Voltaic cell—electrolytic cell
      Industrial application of each

Chlorin
Occurrence
Preparation
  From hydrochloric acid
  From sodium chlorid
  From bleaching powder
Properties
Industrial uses: bleaching, disinfection

Hydrochloric acid
Occurrence
Preparation
  From sodium chlorid and sulphuric acid
Properties—gas and solution
Commercial hydrochloric acid
Formation of chlorids from hydrochloric acid
Test for hydrochloric acid and chlorids

Compounds of nitrogen
- Ammonia
  - Preparation from ammonium salt and alkali
  - Properties
  - Aqua ammonia
  - Anhydrous ammonia
  - Relation of ammonium group to metal
  - Industrial uses of ammonia
- Nitric acid
  - Nitrification
  - Preparation
    - From nitrate and sulphuric acid
  - Properties
  - Industrial uses
  - Test for nitric acid and nitrates
  - Aqua regia
- Oxids of nitrogen—nitrous oxid, nitric oxid, nitrogen peroxid
  - Preparation, properties and uses

Derivation and application of the atomic theory
- Guy Lussac's law of gas volumes
- Avogadro's hypothesis
- Vapor density and molecular weight
- Molecular weights and atomic weights
- Molecular formula
- Molecular equations
- Valence

Carbon
- Occurrence } diamond, graphite, amorphous forms
- Properties }
- Allotropism
- Carbon as a reducing agent
- Industrial uses

Carbon dioxid
- Occurrence
- Preparation and formation
  - Burning of carbon
  - Fermentation
  - Carbonate and acid
  - Heating calcium carbonate
- Properties
- Industrial uses
  - Soda water fire extinguisher

- Test for carbon dioxid and carbonates
- Relation of carbon dioxid to life

Carbon monoxid

- Preparation
  - From carbon by oxidation
  - From carbon dioxid by reduction
  - From oxalic acid
- Properties
- Industrial uses—water gas

Hydrocarbons

- Properties and industrial uses of methane, ethylene, acetylene
- Petroleum
- Natural gas
- Illuminating gas—coal gas, water gas
- Flames and burners
- Bunsen burner and safety lamp
- Oxidizing and reducing flames
- Fluorin, bromin, iodin
  - Occurrence of each element
  - Preparation of each element
  - Properties of each element
  - Industrial uses of each element
  - Study of acids and salts of each element

Sulfur and its compounds

- Sulfur
  - Occurrence and formation
  - Source, extraction, purification
  - Properties
  - Crystalline and amorphous forms
  - Industrial uses
- Hydrogen sulfid
  - Occurrence and preparation
  - Properties
  - Tests
  - Industrial uses
- Sulfur dioxid
  - Occurrence and preparation
  - Properties
  - Relation to sulfurous acid and sulfites
  - Industrial uses
- Sulfur trioxid
  - Preparation
  - Relation to sulfuric acid

Sulfuric acid
- Manufacture
- Properties
- Industrial uses
- Relation to sulfates
- Test for sulfuric acid and soluble sulfates

Boron and silicon
- Boron
  - Occurrence of compounds
  - Boric acid and borax
  - Bead test of boron
  - Industrial uses
- Silicon
  - Occurrence of compounds
  - Silicon dioxid, silicic acid, silicates
  - Glass—manufacture, varieties, industrial uses

Phosphorous, arsenic, antimony, bismuth
- Phosphorus
  - Occurrence of compounds
  - Preparation of the element
  - Comparison of ordinary phosphorous and red phosphorous
  - Relation of oxids to acids
  - Phosphates and phosphites
  - Industrial uses—matches
  - Relation of prosphorous to life
- Arsenic
  - Occurrence of compounds
  - Industrial uses of arsenic trioxid and paris green
  - Marsh's test
- Antimony
  - Occurrence of compounds
  - Properties and industrial uses of the element
- Bismuth
  - Occurrence of the element and compounds
  - Industrial uses of the element

Metals
- General properties and methods of preparation from ores
- Sodium, potassium, lithium
  - Occurrence of compounds
  - Preparation of elements
  - Properties of elements
  - Industrial uses of elements

Preparation and industrial uses of the following compounds—sodium chlorid, sodium carbonate (2 methods), sodium bicarbonate, sodium hydrate, sodium sulfate, sodium nitrate, potassium nitrate, potassium chlorate, potassium carbonate, potassium hydrate, lithium carbonate

Calcium, strontium, barium

Various forms of calcium carbonate in nature

Solubility of calcium carbonate in water bearing carbon dioxid—caves, hard water

Preparation of calcium oxid and calcium hydrate from the carbonate—lime, cement, mortar, whitewash

Various forms of calcium sulfate in nature

Dehydration of gypsum—plaster of paris

Relation of calcium compounds to hardness of water—temporary hardness, permanent hardness

Laboratory and industrial uses of the compounds of strontium and barium

Copper, silver and gold

Copper

Occurrence of the element and compounds

Metallurgy of the element

Purification of the element by electrolysis

Properties of the element

Alloys—brass, bronze, German silver

Comparison of cuprous and cupric compounds

Silver

Occurrence of the element and compounds

Metallurgy of the element

Properties of the element

Alloys—coins

Relation of light to silver salts

Photography

Gold

Occurrence

Extraction and purification

Properties and uses

Alloys—coins

Magnesium, zinc and mercury

Magnesium

Occurrence of the compounds

Properties and uses of the element

Properties of the oxid, chlorid, sulfate

- **Zinc**
  - Occurrence of the compounds
  - Metallurgy of the element
  - Properties and uses of the element
  - Alloys
  - Acid and basic character of the element
  - Properties of the oxid, chlorid, sulfate
- **Mercury**
  - Occurrence of the element and compounds
  - Metallurgy of the element
  - Properties and uses of the element
  - Amalgams
  - Comparison of mercurous and mercuric salts

Aluminium

- Occurrence of the compounds
- Metallurgy of the element
- Properties and uses of the element
- Alums
- Aluminium silicate
  - Kaolin, clay
- Pottery
  - Porcelain, stoneware, earthenware

Tin and lead

- Tin
  - Occurrence of the compound
  - Metallurgy of the element
  - Properties and uses of the element
  - Alloys—pewter, solder
- **Lead**
  - Occurrence of the compounds
  - Metallurgy of the element
  - Properties and uses of the element
  - Alloys—type metal, fusible alloys
  - Lead in drinking water
  - Basic lead carbonate—white lead
  - Oxids—litharge, red lead, brown lead

Chromium and manganese

- Chromium
  - Occurrence of the compounds
  - Properties of potassium chromate, potassium bichromate, lead chromate, chrome alum
  - Acid and basic character of the element

Manganese
- Occurrence of the compounds
- Properties of manganese dioxid, potassium permanganate, manganese sulfate
- Acid and basic character of the element

Iron, nickel and cobalt

Iron
- Occurrence of the element and compounds
- Metallurgy of the element—blast furnace
- Varieties of iron—cast iron, wrought iron, steel
- Manufacture of wrought iron
- Manufacture of steel—Bessemer process
- Hardening and tempering of steel
- Properties of the element
- Properties of ferrous oxid, ferric oxid, ferrous-ferric oxid, ferrous sulfate, ferrous sulfid
- Comparison of ferrous and ferric compounds

Nickel and cobalt
- Occurrence of compounds of nickel
- Properties of nickel
- Nickel plating, nickel steel
- Smalt—cobalt silicate
- Properties of cobalt nitrate, cobalt chlorid

Platinum
- Occurrence of the element
- Properties and uses of the element
- Platinum black, spongy platinum, platinized asbestos

Some organic compounds

Hydrocarbons
- Marsh gas series
- Ethylene series
- Acetylene series

Alcohols
- Preparation and properties of methyl alcohol
- Preparation of ethyl alcohol by fermentation
- Relation of alcohol to wines, beers and distilled liquors

Aldehydes
- Formaldehyde
- Acetic aldehyde

Ethers
- Preparation and use of ethyl ether

Acids
  Fatty acid series—acetic, butyric, palmitic, stearic acids
  Acetic acid
    Preparation by destructive distillation of wood
    Preparation by fermentation from ethyl alcohol—vinegar
Ethereal salts
  Composition of fats
Soap and glycerin
  Treatment of fats to produce soap
  Separation of glycerin from soap
  Chemical nature of soap
  Relation of glycerin to nitroglycerin and to dynamite
Carbohydrates
  Chemical relation between starch, cane sugar, grape sugar
  Manufacture and properties of cane sugar
  Occurrence of grape sugar in nature
  Occurrence of starch in nature
Benzin and its derivations
  Properties of benzin
  Relation of aniline to aniline dyes
  Naphalin—commercial use

Laboratory course A

1 **Comparison of physical change and chemical change**
  a Illustrate physical change by solution of sugar, vaporization of iodin
  b Illustrate chemical change by marble and hydrochloric acid, copper and nitric acid
2 **Study of the nature of the air by aid of phosphorus**
  Effect of phosphorus on the air in a vessel over water
3 **Determination of the per cent of nitrogen and oxygen in the air** (Alkaline pyrogallic acid method)
4 **Preparation and properties of oxygen**
  a Preparation of oxygen by the decomposition of potassium chlorate
  b Comparison of the combustion and products formed by burning the following in oxygen: sulfur, charcoal, phosphorus, iron
5 **Determination of the per cent of oxygen in a weighed sample of potassium chlorate**
  a Estimation of oxygen by loss in weight
  b Weight of liter of oxygen

6 **Preparation and properties of hydrogen**
  a Preparation by the interaction of zinc and sulfuric acid
  b Properties of the gas
  c Crystallization of zinc sulfate from solution

7 **Interaction of metal sodium and water**
  a Evidence of hydrogen formed
  b Evidence of sodium hydrate in the solution

8 **Quantitative examination of the reaction between sulfuric acid and zinc** (Magnesium may be used in place of zinc)
  a Collection of hydrogen from a weighed portion of zinc
  b Calculation of the zinc equivalent to 1 gram of hydrogen

9 **Solubility** (qualitatively)
  a Comparison of solubility of three solids in water
  b Comparison of solubility of three liquids in water

10 **Crystallization**
  a Crystallization from hot solution by evaporation to dryness
  b Crystallization from hot solution by rapid cooling and stirring
  c Crystallization from hot solution by slow cooling without stirring

11 **Supersaturation**
  Separation of sodium thiosulfate from a saturated solution, cooled to a supersaturated condition, by means of a small crystal of the same solid.

12 **Water of crystallization**
  a Evidence of water by heating crystals of gypsum, copper sulfate, iron sulfate
  b Addition of small amounts of water to dehydrated powders and examination of resulting products
  c Efflorescence and deliquescence by exposing sodium sulfate and calcium chlorid to the air

13 **Determination of the per cent of water of crystallization in a weighed sample of barium chlorid**
  Estimation of water by loss in weight

14 **Acids, bases, salts**
  a General properties of acids
  b General properties of bases
  c General properties of several salts

15 **Neutralization** (qualitative)
  a Interaction of sodium hydrate and hydrochloric acid
  b Interaction of potassium hydrate and sulfuric acid
  c Interaction of ammonium hydrate and nitric acid

d Comparison of the salts resulting from the evaporated neutral solutions

16 **A quantitative examination of the interaction of acids and bases, by means of burettes**

a Comparison of the volumes of standard sodium hydrate and standard hydrochloric acid solutions, which neutralize each other.

b Comparison of the volumes of standard potassium hydrate and standard sulfuric acid solutions, which neutralize each other

c Comparison of relative strengths of base solution and of relative strength of acid solution, by calculation

17 **Preparation and properties of chlorin**

a Preparation of chlorin by the interaction of hydrochloric acid and manganese dioxid

b Properties of chlorin

18 **Preparation and properties of hydrochloric acid**

a Preparation of hydrochloric acid by the interaction of sodium chlorid and sulfic acid

b Properties of hydrochloric acid, gas and solution

c Properties of commercial hydrochloric acid

d Test for hydrochloric acid, on a chlorid, by formation of an insoluble chlorid (Silver chlorid)

19 **Preparation of three chlorids**

a Preparation of zinc chlorid by the interaction of zinc and hydrochloric acid

b Preparation of magnesium chlorid by the interaction of magnesium oxid and hydrochloric acid

c Preparation of ammonium chlorid by the interaction of ammonium hydrate and hydrochloric acid

20 **Preparation and properties of ammonia**

a Preparation of ammonia by the interaction of slaked lime and ammonium chlorid

b Properties of ammonia gas

c Properties of ammonium hydrate

21 **Preparation and properties of nitric acid**

a Preparation of nitric acid by the interaction of sodium nitrate and sulphuric acid

b Properties of nitric acid, concentrated and dilute

c Test of nitric acid and nitrates

d Examination of the solid product of the interaction of sodium nitrate and sulphuric acid

22 **Preparation of three nitrates**

a Preparation of iron nitrate by the interaction of iron and nitric acid

b Preparation of copper nitrate by the interaction of copper oxid and nitric acid

c Preparation of sodium nitrate by the interaction of sodium hydrate and nitric acid

23 **Intersection of nitric acid and copper, and study of nitric oxid and nitrogen peroxid**

a Preparation of nitric oxid by interaction of copper and nitric acid

b Properties of nitric oxid

c Preparation of nitrogen peroxid by interaction of nitric oxid and oxygen of the air

d Properties of nitrogen peroxid

24 **Preparation and properties of nitrous oxid**

a Preparation of nitrous oxid by the decomposition of ammonium nitrate by heat

b Properties of nitrous oxid

25 **Distribution and properties of carbon**

a Preparation of carbon by heating wood, cotton, starch, sugar, without free access of air

b Decolorizing action of animal charcoal on indigo solution

c Deodorizing action of charcoal on copper oxid

26 **Preparation and properties of carbon dioxid**

a Preparation of carbon dioxid by the interaction of hydrochloric acid and marble

b Properties of carbon dioxid

c Limewater test for carbon dioxid

27 **Carbonic acid and carbonates**

a Acid effects of a stream of carbon dioxid passed through a solution of sodium hydrate containing an indicator

b Formation of calcium carbonate by passing carbon dioxid through limewater

c Liberation of carbon dioxid from the carbonates in (*a*) and (*b*), by use of hydrochloric acid

d Decomposition of magnesium carbonate by heat

28 **Formation and decomposition of acid calcium carbonate**

a Passage of carbon dioxid through limewater till the precipitate, which first forms has nearly or quite disappeared

b Decomposition of the filtered clear solution by boiling

c Evidence of a carbonate in the precipitate

29 **Determination of carbon dioxid in a carbonate**
Estimation of the per cent of carbon dioxid in a weighed sample of calcite

30 **Preparation of illuminating gas**
a Production of gas by the destructive distillation of soft coal
b Evidence of ammonia and hydrogen sulfid in the gas

31 **Study of flame**
a Construction of a Bunsen burner
b Examination of nonluminous flame with reference to relative heat zones
c Examination of oxidizing and reducing parts of the flame
d Test for kindling temperature of flame
e Examination of parts of candle flame

32 **Preparation and comparison of properties of bromin and iodin with chlorin**
a Preparation of a small amount of bromid by the interaction of potassium bromid, manganese dioxid and sulfuric acid
b Preparation of a small amount of iodin by the interaction of potassium iodid, manganese dioxid and sulfuric acid
c Tabular composition of properties of bromin and iodin with chlorin

33 **Comparative study of the chemism of chlorin, bromin, and iodin by mutual displacement**
a Displacement of bromin from potassium bromid by chlorin
b Displacement of iodin from potassium iodid by chlorin
c Displacement of iodin from potassium iodid by bromin

34 **Preparation an properties of hydrofluoric acid**
a Preparation of hydrofluoric acid by the interaction of calcium fluorid and sulfuric acid
b Properties of the acid, including effect on glass

35 **Study of the forms of sulphur**
a Determination of the melting point of sulfur
b Observations on sulfur between its melting point and its boiling point
c Preparation of crystals from vapor—flowers of sulfur
d Preparation of amorphous sulfur
e Preparation of crystals from liquid—roll sulfur

36 **Preparation and properties of hydrogen sulfid**
a Preparation of hydrogen sulfid by the interaction of iron sulfid and hydrochloric acid
b Properties of the gas
c Test for hydrogen sulfid

37 **Preparation and properties of some sulfids**

a The effect of the action of hydrogen sulfid water on the following substances: clean copper wire, clean sheet lead, bright silver coin, and solutions of lead nitrate, arsenic trioxid (in hydrochloric acid), zinc sulfate

38 **Preparation and properties of sulfur dioxid**

a Preparation of sulfur dioxid by the interaction of sodium sulfite and sulfuric acid

b Properties of the gas

39 **Relation of sulfur dioxid to sulfurous acid and sulfites**

a Test of the acid properties of a solution of sulfur dioxid in water

b Preparation of sodium sulfite by interaction of sulfurous acid and sodium hydrate

40 **Properties of sulfuric acid**

a Effect on organic matter—wood, paper, starch, sugar

b Action on metals to form sulfates

c Test for sulfuric acid and soluble sulfates by formation of an insoluble sulfate (Barium sulfate)

41 **Preparation of three sulfates**

a Preparation of zinc sulfate by the interaction of zinc and sulfuric acid

b Preparation of magnesium sulfate by the interaction of magnesium oxid and sulfuric acid

c Preparation of sodium sulfate by the interaction of sodium hydrate and sulfuric acid

42 **Preparation and properties of silicic acid**

a Preparation of silicic acid by the interaction of sodium silicate and hydrochloric acid

b Properties of silicic acid and silicon dioxid

43 **Mineral growth**

a Interaction of small crystals of soluble salts (nickel nitrate, cobalt nitrate, manganese sulfate, iron sulfate) on a dilute solution of sodium silicate

b Observations on the formations of insoluble silicates

44 **Preparation and properties of compounds of boron**

a Preparation of boric acid by the interaction of borax and hydrochloric acid

b Alcohol test with boric acid

c Borax bead tests with compounds of cobalt, copper, manganese, nickel, iron

45 **Preparation and properties of sodium hydrate**
a Preparation of sodium hydrate by the interaction of sodium carbonate and "milk of lime"
b Zinc sulfate test

46 **Effects of the compounds of certain metals on the flame of the laboratory burner**
Coloration of the flame by small quantities of sodium nitrate, potassium nitrate, lithium carbonate, barium nitrate, strontium nitrate, calcium nitrate

47 **Interaction of copper with metals**
a Displacement of mercury from one of its soluble salts by copper
b Displacement of copper from one of its soluble salts by zinc or iron

48 **Preparation and properties of cuprous oxid**
Deposition of cuprous oxid by the interaction of copper sulfate, Rochelle salt, sodium hydrate and grape sugar (Fehling's solution as a test for sugar)

49 **Preparation of silver**
a Precipitation of silver chlorid by interaction of silver nitrate and hydrochloric acid
b Reduction of silver chlorid to metallic silver by zinc

50 **Tests for magnesium**
a Precipitation of ammonium magnesium phosphate by the interaction of ammonium chlorid, ammonium hydrate, magnesium sulfate and sodium di-phosphate
b Influence of cobaltous nitrate on heated magnesium oxid on charcoal

51 **Comparison of certain mercurous and certain mercuric compounds**
a Mercurous—influence of ammonium hydrate on the interaction of mercurous nitrate and hydrochloric acid
b Mercuric—influence of ammonium hydrate on the interaction of mercuric nitrate and hydrochloric acid

52 **Preparation and properties of common alum**
a Crystallization of potassium aluminium sulfate from a hot saturated solution, prepared from a mixture of aluminium sulfate and potassium sulfate solutions
b Proof that the crystals contain aluminium
c Proof that the crystals are a sulfate
d Proof that the crystals contain water of crystallization
e Identification of the alkaline constituent in an unknown sample of an alum

53 **Some tests for tin**

a Effect of the blowpipe flame on the element

b Effect of interaction of stannous chlorid solution and mercuric chlorid solution

c Effect of strip zinc on an acidulated solution of stannous chlorid

54 **Some tests for lead**

a Effect of blowpipe flame on lead oxid on charcoal

b Effect of hydrogen sulfid on a solution of a lead compound

c Effect of hydrochloric acid on a solution of a lead compound—hot and cold

55 **Acid chromium and basic chromium**

a Preparation of chromium hydrate by the interaction of chrome alum and sodium hydrate

b Preparation of chromium chlorid by the interaction of potassium bichromate, hydrochloric acid, and alcohol

c Oxidation of chromium sulfate to potassium chromate

56 **Oxidation with potassium permanganate**

a Conversion of ferrous sulfate to ferric sulfate by the interaction of potassium permanganate on an acidulated solution of ferrous sulfate

b Effect of a solution of potassium permanganate on organic matter

57 **Ferrous and ferric compounds**

a Preparation of ferrous chlorid by the interaction of iron and hydrochloric acid

b Action on ferrous chlorid by solution of sodium hydrate, by potassium ferricyanid, by potassium thiocyanate

c Conversion of ferrous chlorid into ferric chlorid by a minimum amount of nitric acid

d Action on ferric chlorid by solution of sodium hydrate, by potassium ferrocyanid, by potassium thiocyanate

c Preparation of a blue print to show reduction from ferric to ferrous iron

58 **Fermentation by yeast**

a Fermentation of diluted molasses, or a weak solution of grape sugar, by yeast

b Evidence that the fermentation produces carbon dioxid

c Concentration of alcohol formed, by distillation (if practical)

59 **Preparation and properties of soap**

a Preparation of soap by the interaction of lard and sodium hydrate. Separation of soap by salt solution.

b Litmus paper test of soap solution
c Production of some of the fatty acids by the decomposition of soap solution by dilute sulfuric acid
d Precipitation of "hardness" from very dilute solution of acid calcium carbonate, calcium sulfate, magnesium sulfate, by soap solution

Laboratory course B

1 **Comparison of physical change and chemical change**
a Illustrate physical change by solution of sugar, vaporization of iodin
b Illustrate chemical change by marble and hydrochloric acid; copper and nitric acid
2 **Study of the nature of the air by aid of phosphorus**
Effect of phosphorus on the air in a vessel over water
3 **Preparation and properties of oxygen**
a Preparation of oxygen by the decomposition of potassium chlorate
b Comparison of the combustion and products formed by burning the following in oxygen: sulfur, charcoal, phosphorus, iron
4 **Preparation and properties of hydrogen**
a Preparation by the interaction of zinc and sulfuric acid
b Properties of the gas
c Crystallization of zinc sulfate from solution
5 **Water of crystallization**
a Evidence of water by heating crystals of gypsum, copper sulfate, iron sulfate
b Addition of small amount of water to dehydrated powders and examination of resulting products
c Efflorescence and deliquescence by exposing sodium sulfate and calcium chlorid to the air
6 **Acids, bases, salts**
a General properties of acids
b General properties of bases
c General properties of several salts
7 **Neutralization**
a Interaction of sodium hydrate and hydrochloric acid
b Interaction of potassium hydrate and sulfuric acid
c Interaction of ammonium hydrate and nitric acid
d Comparison of the salts resulting from the evaporated neutral solutions

8 **Preparation and properties of hydrochloric acid**
a Preparation of hydrochloric acid by the interaction of sodium chlorid and sulfuric acid
b Properties of hydrochloric acid, gas and solution
c Properties of commercial hydrochloric acid
d Test for hydrochloric acid or chlorid by formation of an insoluble chlorid (silver chlorid)

9 **Preparation and properties of ammonia**
a Preparation of ammonia by the interaction of slaked lime and ammonium chlorid
b Properties of ammonia gas
c Properties of ammonium hydrate

10 **Preparation and properties of nitric acid**
a Preparation of nitric acid by the interaction of sodium nitrate and sulfuric acid
b Properties of nitric acid, concentrated and dilute
c Test of nitric acid and nitrates
d Examination of the solid product of the interaction of sodium nitrate and sulfuric acid

11 **Interaction of nitric acid and copper, and study of nitric oxid and nitrogen peroxid**
a Preparation of nitric oxid by interaction of copper and nitric acid
b Properties of nitric oxid
c Preparation of nitrogen peroxid by the interaction of nitric oxid and oxygen of the air
d Properties of nitrogen peroxid

12 **Preparation and properties of nitrous oxid**
a Preparation of nitrous oxid by the decomposition of ammonium nitrate by heat
b Properties of nitrous oxid

13 **Distribution and properties of carbon**
a Preparation of carbon by heating wood, cotton, starch, sugar, without free access of air
b Decolorizing action of animal charcoal on indigo solution
c Deodorizing action of wood charcoal on a weak solution of hydrogen sulfid
d Reducing action of charcoal on copper oxid

14 **Preparation and properties of carbon dioxid**
a Preparation of carbon dioxid by the interaction of hydrochloric acid and marble

b Properties of carbon dioxid
c Limewater test for carbon dioxid

15 **Carbonic acid and carbonates**
a Acid effects of a stream of carbon dioxid passed through a solution of sodium hydrate containing an indicator
b Formation of calcium carbonate by passing carbon dioxid through limewater
c Liberation of carbon dioxid from the carbonates in (*a*) and (*b*) by use of hydrochloric acid
d Decomposition of magnesium carbonate by heat

16 **Study of flame**
a Construction of a Bunsen burner
b Examination of nonluminous flame with reference to relative heat zones
c Examination of oxidizing and reducing parts of the flame
d Test for kindling temperature of flame
e Examination of parts of candle flame

17 **Study of the forms of sulfur**
a Observations on sulfur between its melting point and boiling point
b Preparation of crystals from vapor—flowers of sulfur
c Preparation of amorphous sulfur
d Preparation of crystals from liquid, roll sulfur

18 **Preparation and properties of hydrogen sulfid**
a Preparation of hydrogen sulfid by the interaction of iron sulfid and hydrochloric acid
b Properties of the gas
c Test of hydrogen sulfid

19 **Preparation and properties of some sulfids**
The effect of the action of hydrogen sulfid water on the following substances: clean copper wire, clean sheet lead, bright silver coin and solutions of lead nitrate, arsenic trioxid (in hydrochloric acid), zinc sulfate

20 **Preparation and properties of sulfur dioxid**
a Preparation of sulfur dioxide by the interaction of sodium sulfite and sulfuric acid
b Properties of the gas

21 **Relation of sulfur dioxid to sulfurous acid and sulfites**
a Test of the acid properties of a solution of sulfur dioxid in water
b Preparation of sodium sulfite by interaction of sulfurous acid and sodium hydrate

22 **Properties of sulfuric acid**

a Effect on organic matter—wood, paper, starch, sugar

b Action on metals to form sulfates

c Test for sulfuric acid and soluble sulfates, by formation of an insoluble sulfate (barium sulfate)

23 **Preparation and properties of sodium hydrate**

a Preparation of sodium hydrate by the interaction of sodium carbonate and "milk of lime"

b Zinc sulfate test

24 **Effect of the compounds of certain metals on the flame of the laboratory burner**

Coloration of the flame by small quantities of sodium nitrate, potassium nitrate, lithium carbonate, barium nitrate, strontium nitrate, calcium nitrate

25 **Interaction of copper with metals**

a Displacement of mercury from one of its soluble salts by copper

b Displacement of copper from one of its soluble salts by zinc or iron

26 **Preparation and properties of common alum**

a Crystallization of potassium aluminium sulfate from a hot saturated solution, prepared from a mixture of aluminium sulfate and potassium sulfate solution

b Proof that the crystals contain aluminium

c Proof that the crystals are a sulfate

d Proof that the crystals contain water of crystallization

e Identification of the alkaline constituent in an unknown sample of an alum

27 **Some tests for lead**

a Effect of blowpipe flame on lead oxid, on charcoal

b Effect of hydrogen sulfid on a solution of a lead compound

c Effect of hydrochloric acid on a solution of a lead compound—hot and cold

28 **Ferrous and ferric compounds**

a Preparation of ferrous chlorid by the interaction of iron and hydrochloric acid

b Action on ferrous chlorid by solution of sodium hydrate, by potassium ferricyanid, by potassium thiocyanate

c Conversion of ferrous chlorid into ferric chlorid by a minimum amount of nitric acid

d Action on ferric chlorid by solution of sodium hydrate, by potassium ferrocyanid, by potassium thiocyanate

29 **Fermentation by yeast**

a Fermentation of diluted molasses, or a weak solution of grape sugar, by yeast

b Evidence that the fermentation produces carbon dioxid

c Concentration of alcohol formed by distillation (if practical)

30 **Preparation and properties of soap**

a Preparation of soap by the interaction of lard and sodium hydrate. Separation of soap by salt solution

b Litmus paper test of soap solution

c Production of some of the fatty acids by the decomposition of soap solution by dilute sulfuric acid

d Precipitation of "hardness" from very dilute solution of acid calcium, carbonate, calcium sulfate, magnesium sulfate, by soap solution

Respectfully submitted

GEORGE M. TURNER, *Chairman*
ERNEST R. VON NARDROFF
O. C. KENYON

It was moved and seconded that the report of the committee be adopted by the association, earnestly recommended to the State Education Department as a basis for the work in physics and chemistry for the secondary schools of the State for the time period of the next syllabus, and ordered printed in the proceedings of this association for the current meeting. *Carried*

MEMBERS 1905

When the name of an institution includes the name of its town or city, the latter is not repeated. Where no state abbreviation is given, New York is to be understood.

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Hersey, C. Brooks, Masten Park High School, Buffalo

Hill, R. V., Jamestown High School
Holdredge, F. I., Hudson High School
Holly, Harold A., Warsaw High School
Hudson, George H., Plattsburg Normal School
Humphrey, O. D., Jamaica Normal School
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Karr, Grant, Oswego Normal School
Keller, Christopher, Luzerne High School
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